Planning Assistance to States Program, Maine

FINAL

Maine Department of Transportation Coastal Wetland Tidal Restriction Study

May 2004

US Army Corps of Engineers

New England District

Planning Assistance to States

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Department of the Army
Corps of Engineers, New England District
Concord, Massachusetts

May 2004

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Project Background

Transportation facilities such as bridges, culverts, and tide gates at road crossings may restrict tidal flow to coastal wetlands unless properly designed and constructed.

The Maine Department of Transportation (ME DOT) is interested in identifying degraded coastal wetlands affected by transportation crossings that may be reasonable coastal wetland restoration candidates. This information could be used by ME DOT to consider making necessary modifications to the facilities during future maintenance and replacement activities and for wetland mitigation purposes.

Study Authority

The New England District of the Corps of Engineers Planning Assistance to States (PAS) Program conducted this investigation. The study was performed under a cost sharing agreement with the Maine Department of Transportation.

Authorization for the PAS program is contained in the Water Resources Development Act of 1974, Public Law 93-251 as amended. Section 319 of the Water Resources Development Act of 1990, Public Law 101-640, provides authorized study cost sharing at 50 percent federal/50 percent non-federal.

Tidal Restrictions

Tidal restrictions are manmade structures (e.g., roads, bridges, dikes/dams, and other barriers) that may restrict the ebb and flow of saltwater into upstream habitats that were historically inundated by the tide. The loss of the natural saltwater flushing and flooding in a coastal marsh results in changes in water and soil chemistry that in turn can result in changes in vegetation types, water quality, and the value of the marsh habitat. Often changes are marked by monotypic stands of invasive vegetation such as Common Reed (*Phragmites australis*) and purple loosestrife that replace the typical salt marsh vegetation. These invasive species have low ecological value. Under altered tidal flow conditions, invasive plants can out compete the natural coastal plant community. The reduced tidal regime and the dominance by Common Reed reduce the area of higher value estuarine habitat and the amount of higher value salt marsh vegetation. Removing tidal restrictions will often restore degraded habitats to salt marsh. Generally, removal of a tidal restriction will result in

increased flushing and flooding with salt water and create conditions unfavorable to invasive species.

Study Purpose and Area

The purpose of this study is to assist ME DOT with the identification and initial assessment of potentially tidally restricted coastal wetland sites. The focus of the study was sites where culvert or bridges were associated with state or town roads.

The study area included the Maine coastal area from the Scarborough marsh to the Sheepscot River in Wiscasset. This included the coastal areas as defined by 15 United States Geological Survey quadrangles (USGS quadrangles). The Quadrangles are listed in Table 1 and shown in Figure 1.

Table 1. USGS Quadrangles List

	Quadrangle Name	**Abbreviation used in this report**
1	BAILEY-ISLAND	BAI
2	BATH	BAT
3	BOOTHBAY-HARBOR	BBH
4	BRUNSWICK	BRK
5	CAPE-ELIZABETH	CEL
6	FREEPORT	FPT
7	ORRS-ISLAND	ORI
8	PHIPPSBURG	PHI
9	PORTLAND-EAST	PTE
10	PORTLAND-WEST	PTW
11	PROUTS-NECK	PRT
12	SMALL-POINT	SMP
13	SOUTH-HARPSWELL	SHA
14	WESTPORT	WPT
15	YARMOUTH	YAR

SITE EVALUATIONS

Database Development

Identification and location of potential tidal restrictions were developed through use and review of the Conservation Law Foundation's "Return the Tides" (CLF) tidal wetlands database. In 2000, CLF program identified sites that were thought to involve a road, railroad, or other crossing feature at or near a coastal wetland. Hard copies of USGS quadrangles with sites marked by hand were provided to the Corps for its use. The Corps digitized these site locations into an ARC VIEW GIS shape layer. This layer was then used with other available data layers such as digital ortho-photographs from USGS, quadrangles from USGS, the Coastal Marine Geological Environment Series maps (Maine Geological survey, CMGES), and the USFWS National Wetland Inventory (NWI) data for Maine. From visual review of the GIS data layers, a study database was developed of potential tidal restriction sites. The database included the crossing site identification label (from CLF), an estimate of wetland area upstream of the crossing that might be impacted by the crossing, the town name, and the restriction type.

Sites were visually reviewed in the office by Corps staff using the data layers noted above. Many of the sites, although at a roadway or railroad, did not appear to be located such that a tidal restriction would likely occur. Sites such as these were assigned a zero wetland impact value. Sites that might have a potential restriction were assigned wetland acreage values greater than zero based on the CMGES and NWI data layers.

Site Selection Process

A total of 272 wetland/infrastructure crossing sites were initially identified between Scarborough and the Sheepscot River. These sites were then visually reviewed as described above and resulted in identification of 121 sites that might have tidal wetland restrictions (possible acres impacted greater than zero). Appendix 11 contains a listing of the 272 sites. All site locations are shown in the study site map folded in the back of this report. (The Little John Island site was not included in the 272 sites, but was added at the request of MEDOT.)

In order to select 10 sites for initial site investigations (tidal monitoring and general vegetation review) this site list was reviewed by ME DOT and the Corps. Selection for monitoring considered the relevance of a site to ME DOT either as a current or future repair project or as a mitigation site. ME DOT has replacement responsibilities in bridges over 10 feet in length (any road) and culverts on state numbered roads.

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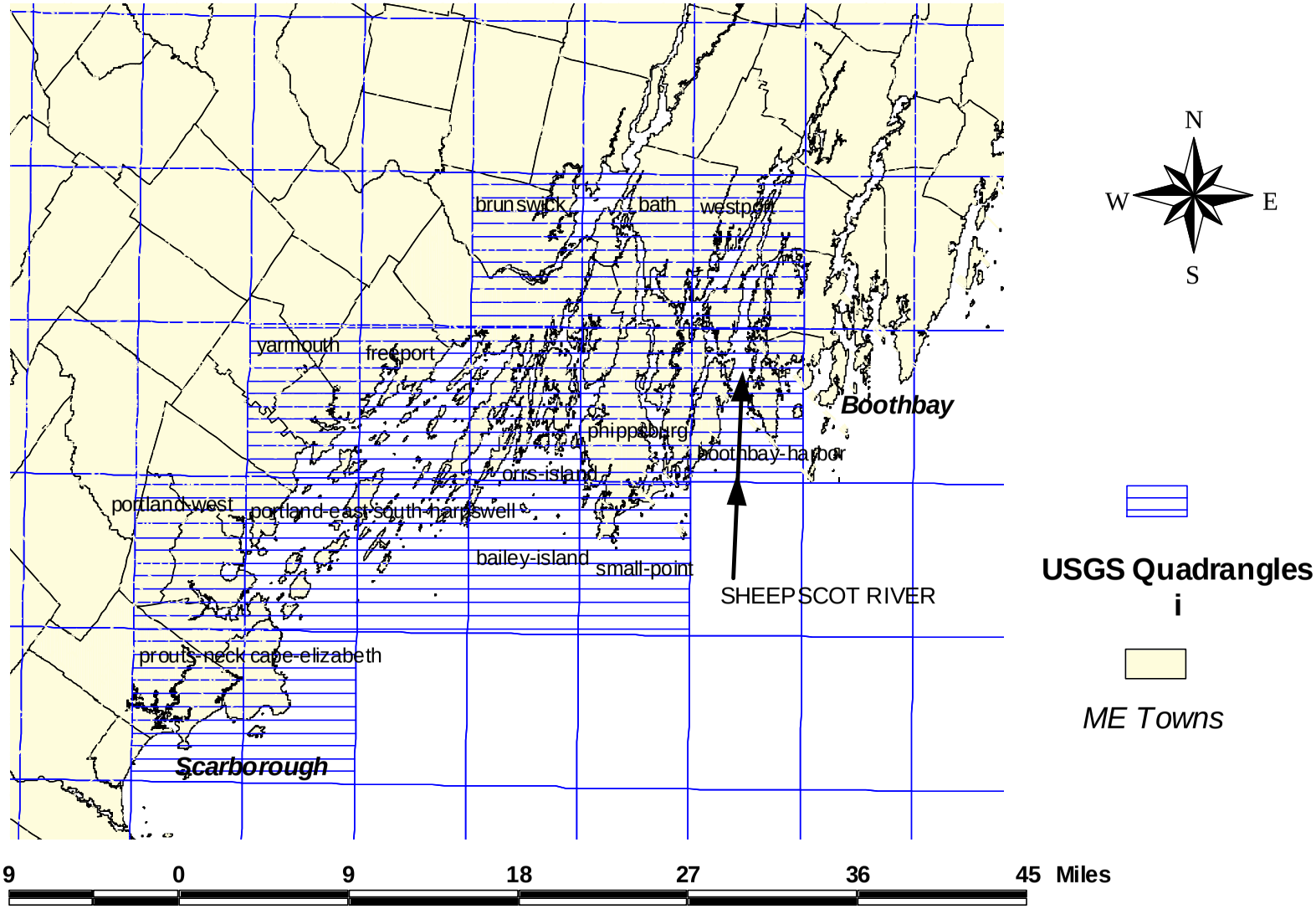
15	YARMOUTH	YAR



ME DOT Study Area

Figure 1

SITE EVALUATIONS

Database Development

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The site lists were discussed with US Fish and Wildlife Service, Maine State Planning Office, Ducks Unlimited, and Conservation Law Foundation at meetings on April 19, 2002 and May 10, 2002. In addition, brief field visits were made to the sites by Corps and ME DOT staff. From this review process, 10 sites were selected for initial field investigations.

Field Investigations

The 10 sites selected for initial field investigations are shown in Figure 2. Five sites were visited in fall 2002 and 5 were visited in spring 2003. Investigations included tidal monitoring for one tide cycle and identification of major vegetation types present at the site. The sites investigated ranged geographically from the Littlejohn Island (LJI) site in Yarmouth to the WPT 17 in Westport.

Tidal Characteristics. The tidal regime in the project area is semi-diurnal, with two high and low waters occurring during each lunar day (approximately 24 hours and 50 minutes). The resulting tide range is constantly varying in response to the relative positions of the earth, moon, and sun, with the moon having the primary tide-producing effect. Maximum ranges occur when the orbital cycles of these bodies are in phase. The monthly tide ranges that occur at or near the time of the new or full moon, rise the highest above and fall the lowest below from mean sea level. These times are called spring tides.

The project area falls between the Portland and Rockland, Maine NOS Tide Stations. The Portland station has a tide range of about 9.9 feet from MHHW to MLLW. The Rockland station has a tide range of about 10.6 feet from MHHW to MLLW. Although exact tidal characteristics are lacking at the site, the predicted tide range at each of these sites was estimated using the Portland Tide Station Data.

The estimated tide range for each site is determined by multiplying the Portland predicted value by a correction factor. The sites that are north of Portland in the maze of islands and peninsulas generally experience a slightly reduced tide range compared to Portland. Information on tide range at each site is included in Table 2. Staff gages used for monitoring were 12 feet in length and set-up to capture the full tide range for the event monitored. These gages were also referenced to NAVD88 so comparisons in water elevations could be made between the upstream and downstream gages.

Tide readings were collected at the sites during predicted spring tide conditions. As a result, observed high tide elevations in the marsh for the measured events will be nearly the highest for any tidal condition, other than those created by storm conditions. With higher

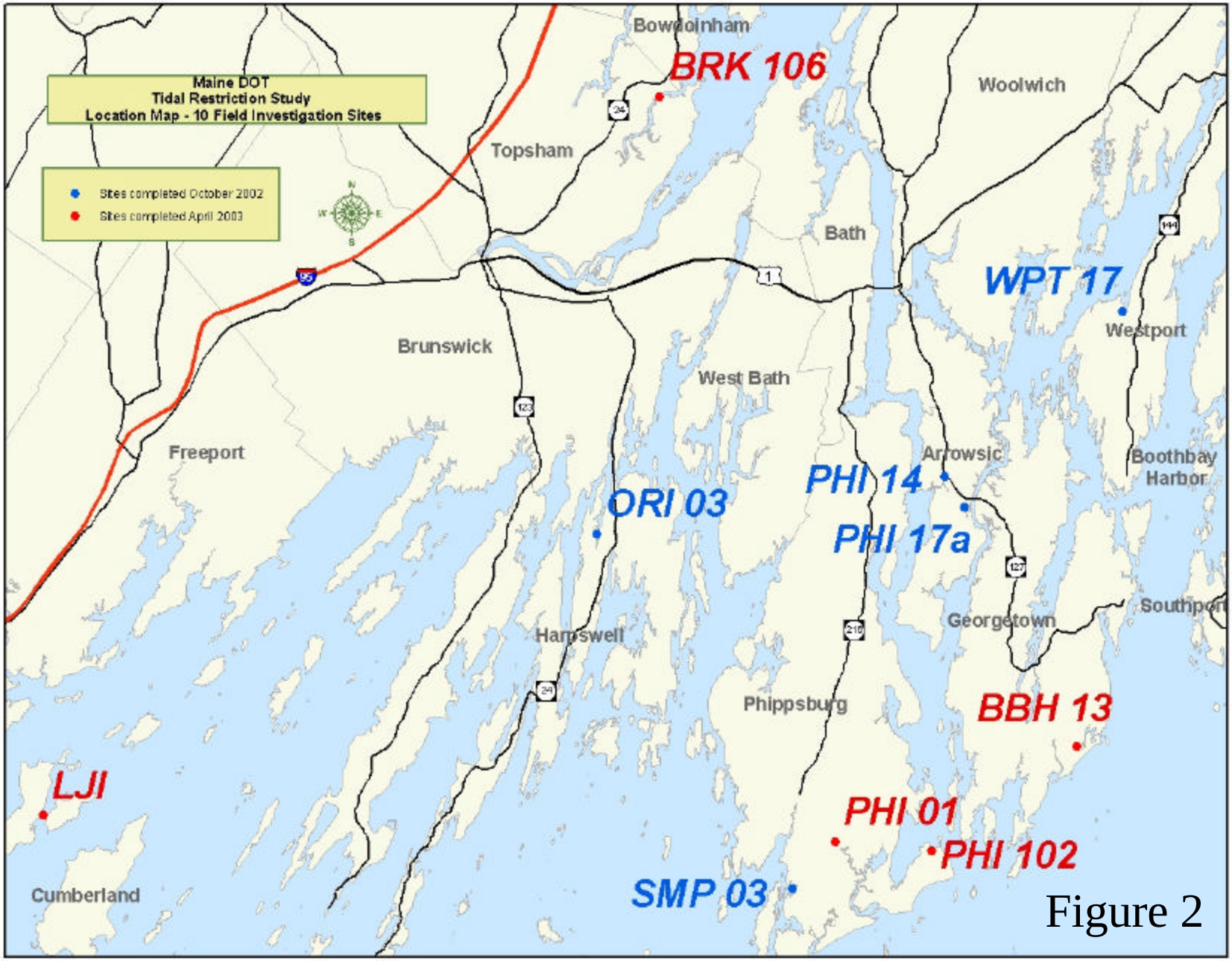

Maine DOT
Tidal Restriction Study
Location Map - 10 Field Investigation Sites
Sites completed October 2002
Sites completed April 2003
Bowdoinham
BRK 106
Topsham
Woolwich
Bath
WPT 17
Westport
Brunswick
West Bath
Freeport
Arrowsic
Boothbay Harbor
PHI 14
ORI 03
PHI 17a
Georgetown
Southport
Harpswell
Phippsburg
BBH 13
LJI
PHI 01
PHI 102
SMP 03
Cumberland

Figure 2

tide heights, larger difference in water surface elevation and lag times can be expected. Results of tidal measurements are discussed in the individual assessments.

Table 2. Estimated Tide Ranges

Site ID	Closest predicted tide station	Distance	Correction factor to Portland Station	Estimated tide range, feet
BBH 13	Fort Popham	3.7 miles	0.92	9.1
BRK 106	Merrymeeting Bay	2.0 miles	0.58	5.8
LJI	Chebeaque Point	2.0 miles	0.99	9.8
ORI 03	Prince Point	3.2 miles	0.88	8.8
PHI 01	Small Point	2.0 miles	0.97	9.6
PHI 14	Phippsburg Station	2.8 miles	0.88	8.8
PHI 17a	Phippsburg Station	2.8 miles	0.88	8.8
PHI 102	Fort Popham	0.25 miles	0.92	9.1
SMP 03	Small Point Harbor	0.3 miles	0.97	9.6
WPT 17	Mills Point Station	3.6 miles	0.97	9.6

Freshwater Drainage Area. Approximate freshwater drainage areas were determined at each site based on the USGS quadrangles. These are included in Table 3. The freshwater drainage areas at the sites ranged in size from about 45 acres to 2015 acres. Although these drainage areas are relatively small, all sites are likely influenced to some extent by local freshwater run off and groundwater inflow.

Table 3. Estimated Site Watershed Area	
Site ID	**Acres**
BBH 13	166
BRK 106	2,015
LJI	Not applicable
ORI 03	218
PHI 01	211
PHI 14	166
PHI 17	102
PHI 102	45
SMP 03	192
WPT 17	70

Site Salinity. During the field visits water salinity was measured at each site using a hand held refractometer. Observed salinity measurements are included in the site assessments. Salinity is a measure of the salt water concentration measured in parts per thousand (ppt). Higher salinity means more dissolved salts.

An estuary can be characterized by the amount of tidal influence and salinity of the water. The major salinity regimes are, from least saline to most saline:

- **Tidal Fresh** – Describes waters with salinity between 0 and 0.5 parts per thousand (ppt). These areas are at the extreme reach of tidal influence.
- **Oligohaline** – Describes waters with salinity between 0.5 and 5 ppt. These areas are typically in the upper portion of an estuary.
- **Mesohaline** – Describes waters with salinity between 5 and 18 ppt. These areas are typically in the middle portion of an estuary.
- **Polyhaline** – Describes waters with salinity between 18 and 30 ppt. These areas are typically in the lower portion of an estuary, where the ocean and estuary meet.

Coastal wetlands are generally referred to as salt or brackish marshes depending on the type of vegetation and salinity regime; with brackish marshes having less salinity. The amount of salinity is an important parameter that determines in part the type of vegetation that will grow in a marsh. Dominant salt-marsh species include cordgrass *(Spartina alterniflora),* and salt hay (*Spartina patens*). Brackish marsh species include narrow-leaf cattail (*Typha angustifolia*), the rushes (*Scirpus sp*.)and seaside goldenrod (*Solidago*

sempervirens). These brackish marsh areas may become dominated by *Phragmites australis* and *T. angustifolia.*

Vegetation Analyses. Vegetation types described for each site were based on visual observations during site visits. Maps generated are not intended to provide a detailed vegetation survey, but to document the general ecological conditions at a site. Vegetation maps are included in the site assessments.

Site Summary

Table 4 contains a summary of findings for the 10 sites investigated. Of the ten sites investigated 8 are potential canidate restoration sites.

One indicator of salt marsh restriction is the replacement of salt marsh grasses with invasive species such as common reed (*Phragmites*). Of the 10 sites investigated, *Phragmites* was found at two of the sites.

Of the 10 sites investigated 7 had tidal restrictions, although in most cases the marshes above the culverts still appeared to support salt marsh grasses.

Table 3. Maine DOT Tidal Restriction Study - Summary of 10 sites investigated

Site ID	Crossing Type	Potential Restriction	Town	Wetland area above crossing (acres)	High Tide restriction observed in feet	Phargmites observed	Potential candidate restoration site
BBH 13	Todd Point Road, in Reid State Park	two 48-inch diameter corrugated metal culverts	Georgetown	24	0.05 ft.	no	No, culverts appeared to be in good condition and allow for full tidal exchange.
BRK 106	Foreside Road - town road but MEDOT responsible for bridge	bridge over Muddy River	Topsham	430	none	no	No, the existing bridge opening does not cause a tidal restriction
LJI	Liitlejohn Island Road - town road but ME DOT responsible for bridge	causeway and bridge (70 ft. wide)	Yarmouth	not applicable	none	no	Yes, Although the tide range is the same on both sides of the causeway. The causeway may have altered tidal circulation patterns and this might affect the quality of the aquatic habitat north of the causeway. Further study is suggested.
ORI 03	Long Reach Lane (town)	concrete culvert, 3 ft diameter	Harpswell	29	1.4 ft.	no	Yes, culverts causes restriction. This is a site to continue to monitor and if invasive vegetation begins to establish itself then consider providing for increased tidal exchange .
PHI 01	State Route 209	stone box culvert (5X2 ft.)	Phippsburg	10	0.1 ft.	yes	Yes, culvert does cause a reduction in tide range. ME DOT should consider replacing existing culvert or adding a second culvert at a lower elevation to improve marsh drainage.
PHI 14	State Route 127	culvert- corrugated metal pipe (5 ft. diameter)	Arrowsic	26	0.8 ft.	no	Yes, marsh is dominated by cattail. Further investigation to determine how salinities in this area vary with time and investigate the effect of the Kennebec River.
PHI 17	Indian Rest Road (town)	culvert - corrugated metal (3ft. diameter)	Arrowsic	7	1.3 ft.	no	Yes, the existing culvert causes a tidal flow restriction both at high and low tide.
PHI 102	State Route 209 near Popham Beach	two 24 inch diameter PVC culverts	Phippsburg	3	none	yes	Yes, drainage appears to be impacted by the vegetation and sediment build-up at the culverts. Clearing this area would improve marsh drainage at low tide.
SMP 03	State Route 216	stone box culvert (5X2 ft.)	Phippsburg	12	1.25 ft.	no	Yes, tidal exchange appears to be impacted by the existing culvert.
WPT 17	State Route 144S	Metal corrugated culvert (5.5X4.5)	Westport	37	2.7 ft.	no	Yes, tidal exchange appears to be impacted by the existing culvert.

Appendix 1

BBH 13

APPENDIX 1

Site: BBH 13

Water Body Stream/ Name: Sheepscot Bay/Atlantic Ocean
Town: Georgetown, Maine at Reid State Park
USGS Quadrangle Name: Boothbay Harbor, Maine
Estimated Wetland Area Above Crossing: 24 acres estimated

General

The culvert at the site is located under Todd Point Road in Reid State Park. See photographs of BBH 13 figures 1 and 2.

Vegetation Information:

A site visit was made on May 12 and general vegetation types identified. (See Vegetation Map BBH 13). General vegetation types observed were salt marsh grasses. There was a small area of cattail observed along the southwest corner of the marsh.

Salinity

Salinity was measured at the site on an outgoing tide using a hand held refractometer. Salinity on the outgoing tide was measured at 10 parts per thousand (ppt.) and may reflect some freshwater influence at the site. Because of the proximity and direct connection of the site to the open ocean, it is expected that salinity on an incoming tide would be in the range of 20 to 30 ppt.

Culvert Information

There are two 48-inch diameter corrugated metal pipes running perpendicular to the road. The culverts appear to be in good condition with no problems evident. The culverts were designated as the north culvert and the south culvert. The north culvert had a marsh side invert of 0.77 feet NAVD88 and the south culvert had a marsh side invert of 0.87 feet NAVD88. The north culvert and south culvert had ocean side inverts of 0.85 feet and 0.67 feet, respectively. The culverts were measured to be 56.5 feet long (invert edge to invert edge).

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on April 18, 2003. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured

on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevations to be recorded to the nearest 0.05 foot. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in BBH 13 tide data plot. (Figure 3).

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 0.05 feet with a time lag of only several minutes.

Observed Restriction at Low Tide

The figure shows that the marsh reaches the same elevation as the ocean side channel with little or no lag in time. It was observed that the marsh and ocean side marsh essentially go dry with only puddles remaining.

Flooding Impacts

The area surrounding the marsh is primarily wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit.

Summary of Findings

1. The culverts appeared to be in good condition.

2. There does not appear to be any significant tidal restriction due to these culverts.

Site BBH 13 - Ocean side of Culvert at Todd Pt. Road

Site BBH 13 - View marsh side of culvert at Todd Pt. Road

April 2003

BBH 13, Georgetown Maine at Reid State Park

Figure 1

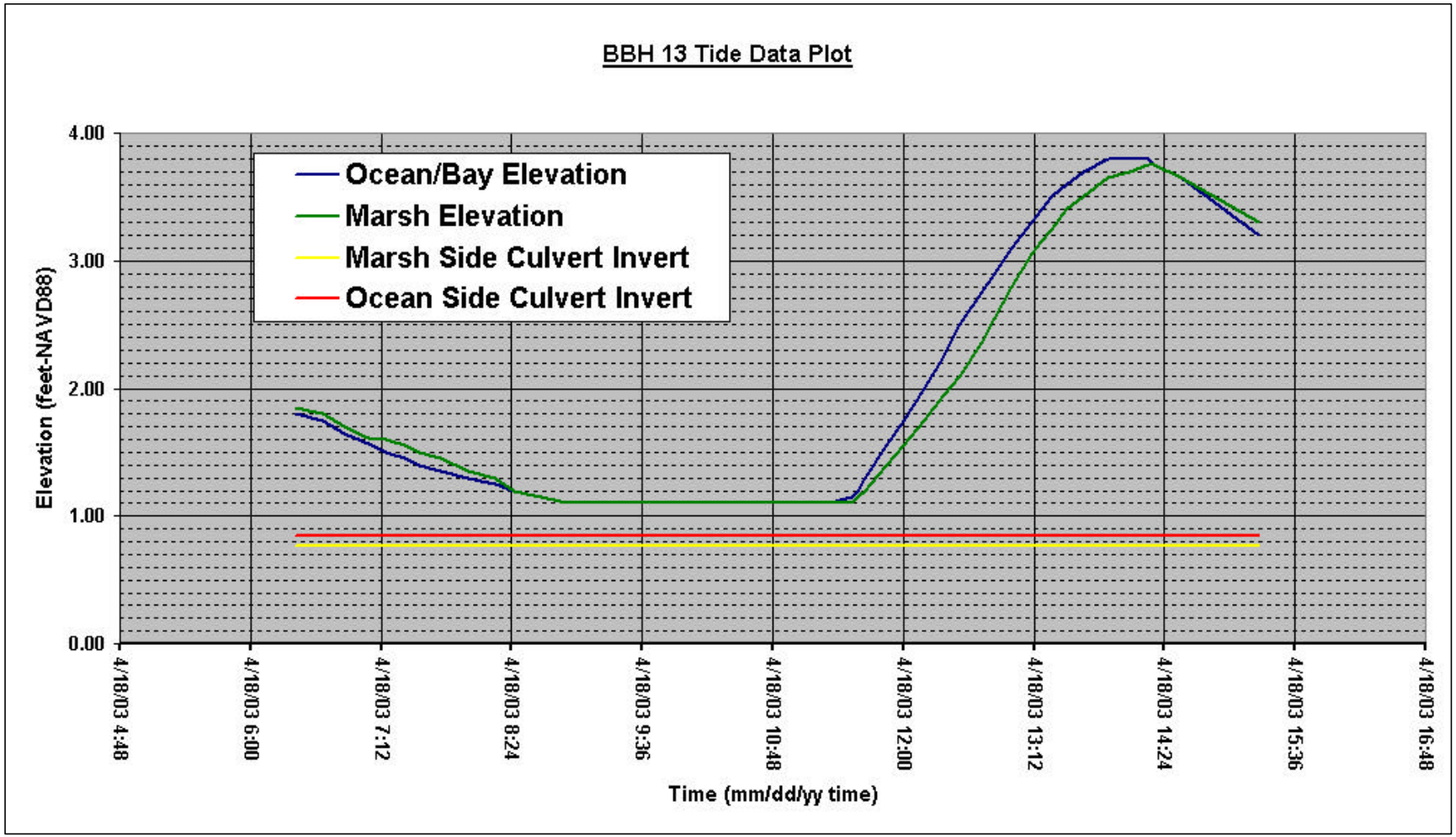
Site BBHI 13 - Typical view on Ocean side of Todd Pt. Road

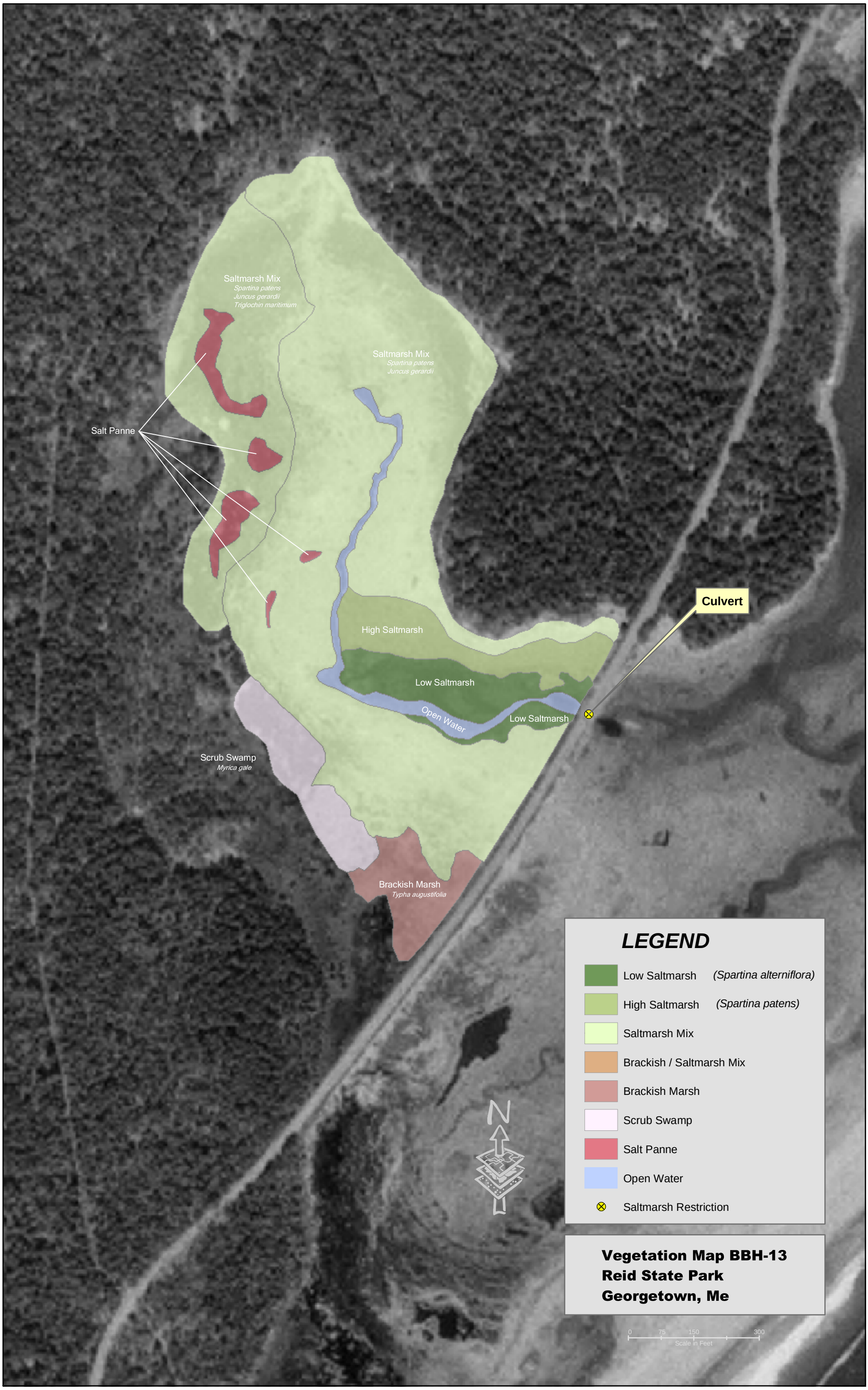
Site BBH 13 - Typical view on Marsh side of Todd Pt. Road

April 2003

BBH 13, Georgetown Maine at Reid State Park

Figure 2


BBH 13 Tide Data Plot
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Culvert Invert
Ocean Side Culvert Invert
Elevation (feet-NAVD88)
4.00
3.00
2.00
1.00
0.00
4/18/03 4:48
4/18/03 6:00
4/18/03 7:12
4/18/03 8:24
4/18/03 9:36
4/18/03 10:48
4/18/03 12:00
4/18/03 13:12
4/18/03 14:24
4/18/03 15:36
4/18/03 16:48
Time (mm/dd/yy time)


Saltmarsh Mix
Spartina patens
Juncus gerardii
Triglochin maritimum
Saltmarsh Mix
Spartina patens
Juncus gerardii
Salt Panne
Culvert
High Saltmarsh
Low Saltmarsh
Open Water
Low Saltmarsh
Scrub Swamp
Myrica gale
Brackish Marsh
Typha augustifolia
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
N
Vegetation Map BBH-13
Reid State Park
Georgetown, Me
0
75
150
300
Scale in Feet

Appendix 2

BRK 106

APPENDIX 2

Site: BRK 106

Water Body Stream/ Name: Bridge across Muddy River
Town: Topsham, Maine
USGS Quadrangle Name: Brunswick, Maine
Estimated wetland Area Above Crossing: 430 acres

General

This bridge is located over the Muddy River on Foreside Road. The bridge is located about a mile upstream from Merrymeeting Bay.

Vegetation Information

A site visit was made on May 12, 2003. From the bridge some fringing cattail stands were observed along the river both upstream and downstream of the bridge. See Vegetation Map BRK 106. From the USGS quadrangle shown in Figure 1 it appears that there is a large wetland complex upstream of the bridge along the river. However, based on our observations at the bridge, the area upstream of the bridge is not likely to support salt marsh vegetation.

Salinity

Salinity was measured at the bridge on May 12 using a hand held refractometer. The one measurement indicated a freshwater environment. As this site is tidal it may be that salinities increase on an incoming tide.

Bridge Information

Unlike most of the other sites the water/wetland crossing was a large bridge opening. The bridge opening was measured to be approximately 100 feet wide. It appeared that the opening was large enough to allow unrestricted flow. It also appeared that the marsh was identical on both sides of the bridge.

Tide Data

To determine the impact of the bridge on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on April 18, 2003. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on the west (upstream) side of the bridge using a temporarily installed tide board. The board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. The plot showing the water elevation on the west side of the bridge and the water elevation down stream in Merrymeeeting Bay can be seen in

the BRK106 tide data plot. The Merrymeeting Bay data was obtained using the NOS prediction correction from Portland, ME and then applying an estimated correction to NAVD88. The NAVD88 correction was developed using mean tide level (MTL). It must be understood that this was an estimate and should only be used in this study. This should not be taken as the actual correction.

Observed Restriction at High tide

Based upon the elevation data collected there does not appear to be a tidal restriction caused by the bridge at high tide.

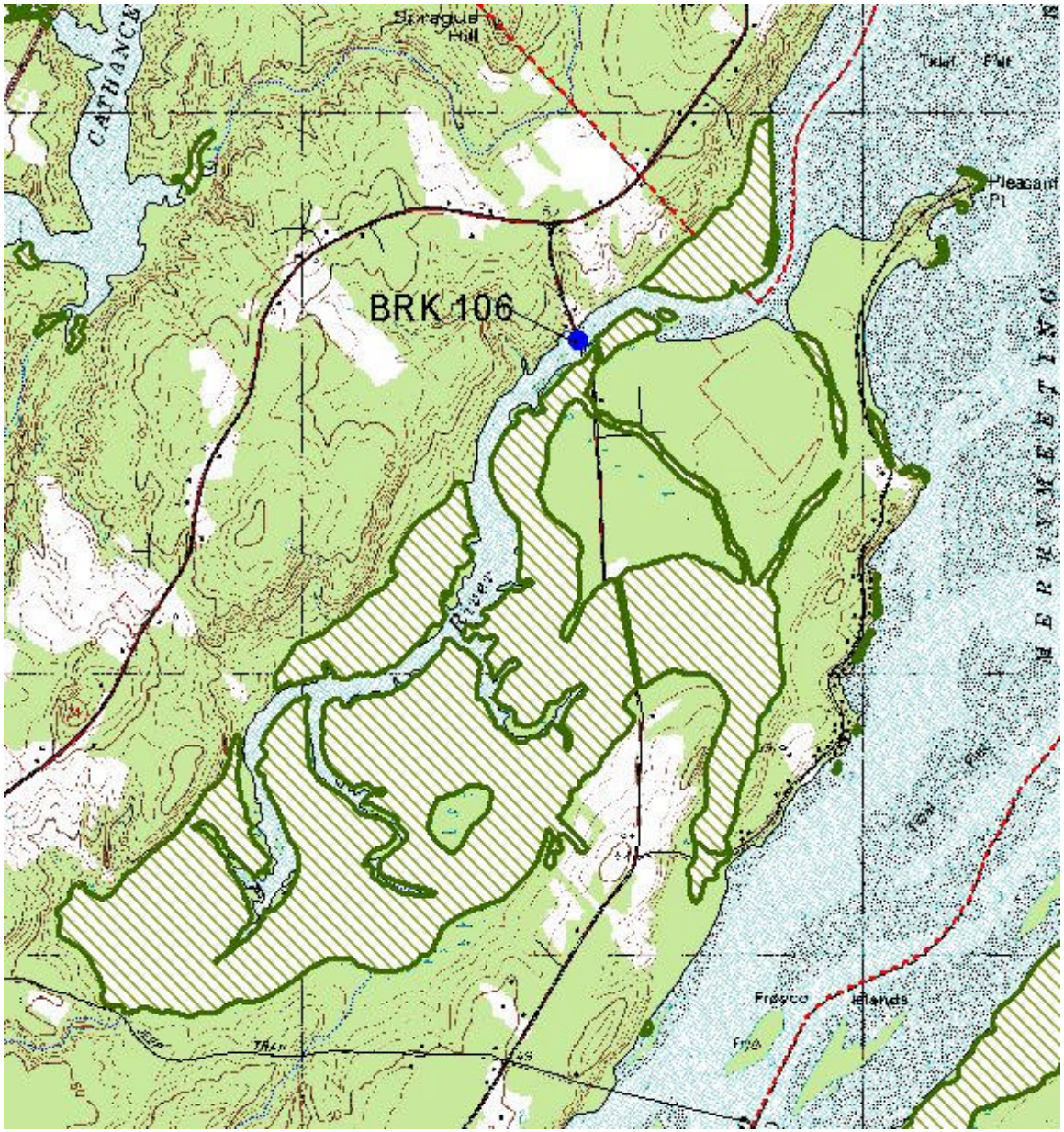
Observed Restriction at low tide

Low tide was not observed due to large amounts of marsh debris on the tide board. However, considering the nearly unrestricted opening and the unrestricted high tide elevation it would be expected that no restriction would occur at low tide.

Summary of Findings

1. The existing Bridge opening does not cause a tidal restriction.

2. Further site investigations would be required to determine how much the river water quality characteristics are influenced by the tidal inflow.



April 2003

BRK 106. Topsham, Maine

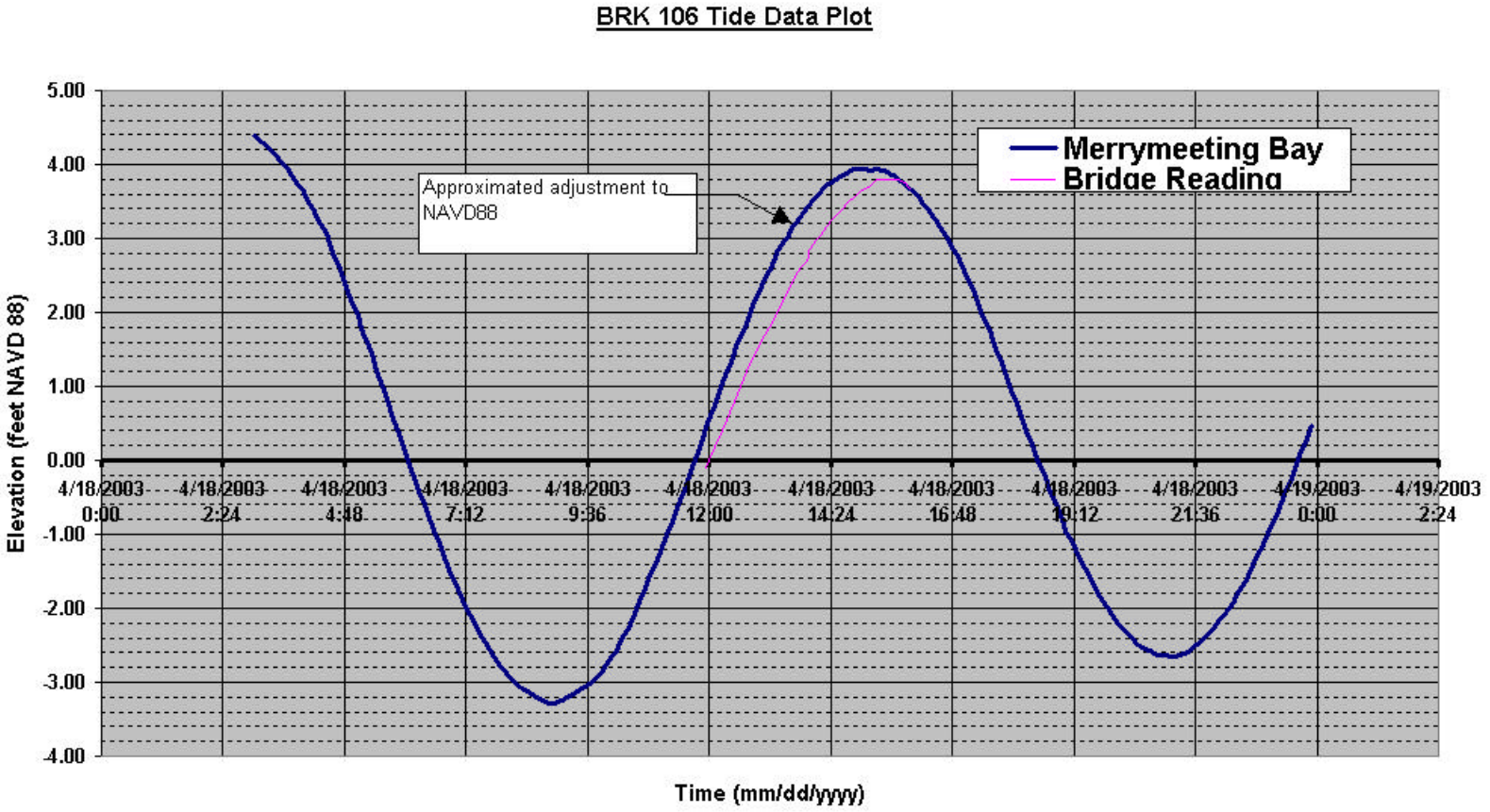
Figure 1

Upstream Side of Bridge

Downstream Side of Bridge

Typical view upstream of Bridge

Typical view downstream of Bridge


BRK 106 Tide Data Plot
Approximated adjustment to NAVD88
Merrymeeting Bay
Bridge Reading
Elevation (feet NAVD 88)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
4/18/2003 0:00
4/18/2003 2:24
4/18/2003 4:48
4/18/2003 7:12
4/18/2003 9:36
4/18/2003 12:00
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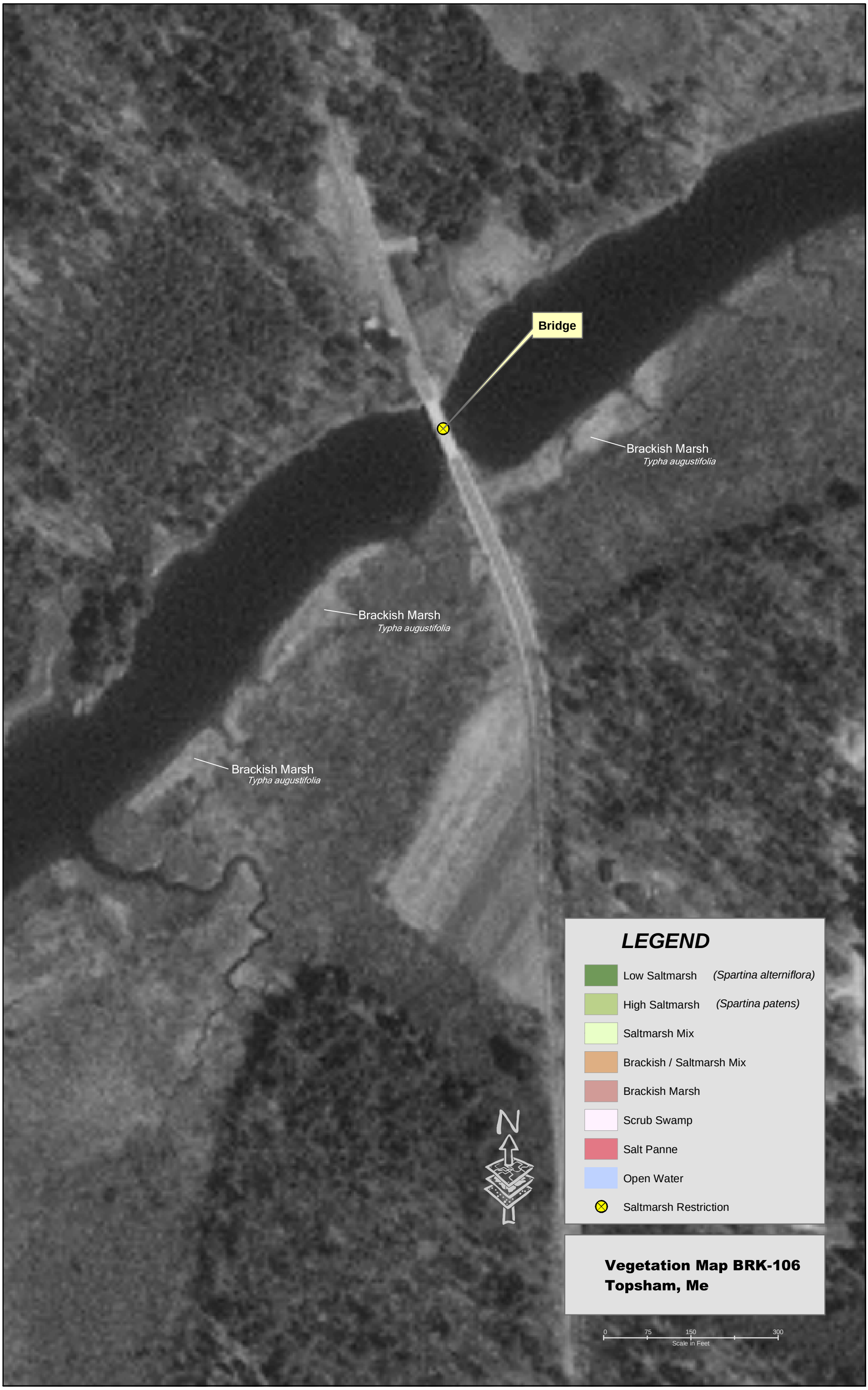
4/19/2003 2:24
Time (mm/dd/yyyy)


Bridge
Brackish Marsh
Typha augustifolia
Brackish Marsh
Typha augustifolia
Brackish Marsh
Typha augustifolia
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map BRK-106
Topsham, Me
0
75
150
300
Scale in Feet

Appendix 3

LJI

APPENDIX 3

Site: LJI

Water Body Stream/name: Casco Bay
Town: Yarmouth
USGS Quadrangle Name: Yarmouth, Maine
Estimated Wetland Area above Crossing: not applicable

General

The bridge site is located on Littlejohn Island Road (town road) in Yarmouth, Maine. This site was included for tidal monitoring and general vegetation mapping during the Corps and Maine Department of Transportation (ME DOT), Coastal Wetlands Tidal Restriction study at the request of ME DOT. ME DOT is in the process of replacing the bridge for safety reasons and their current funding only allows for in-kind replacement of the existing bridge. The bridge is the only opening in a riprap causeway between Littlejohn Island and Cousins Island. The existing bridge is about 70 ft. in length and the causeway is about 600 ft. in length. A local resident's group is concerned that in-kind replacement will not address negative environmental conditions related to the existing bridge condition.

The original bridge between Littlejohn Island and Cousins Island was built around 1841 and was a wooden bridge on piers. This bridge allowed for larger cross-sectional flow area than currently exists. In the late 1960's the wooden pile bridge was replaced by the filled causeway and smaller bridge by the Town of Yarmouth. Since that time ME DOT has become responsible for maintenance of the bridge. Local residents are concerned that that the smaller bridge opening has altered the flow regime between the islands. The altered flow regime between the islands may be causing increased sediment deposition north of the causeway and may negatively impact water quality. These changes may be negatively affecting the habitat characteristics of the 22-acre clam-flat to the north of the causeway. (Source: Letter from Ann Thayer to Jim Wentworth, ME DOT, dated August 7, 2002 and discussions with Mark Lickus, ME DOT.)

Vegetation Information

A vegetation cover-type map of the site was generated based on a field visit on May 13, 2003. Fringing coastal wetlands were observed both upstream and downstream of the causeway. See Vegetation map for site LJI. This type of habitat is typically of value to finfish and shellfish. The Wells National Estuarine Research Reserve in Maine is currently conducting a study of the value of this habitat type in Casco Bay and the fringing wetlands noted here are included as part of their study. (Telecom: Paul Dest, Reserve Manager, Wells National Estuarine Research Reserve, Wells, ME, May 15, 2003.)

Salinity

Salinity was measured at the bridge on May 13, 2003 with a hand held refractometer. A salinity of 30 parts per thousand was observed in the main channel area under the bridge. This measurement indicates normal marine salinity conditions. No measurements were made in the area upstream of the causeway.

Bridge Information

The bridge is about 70 ft. long with two pile base piers. The channel invert (elevation of the stream bottom) measured was –2.74 feet NAVD88. The channel banks underneath the bridge are armored with stone rip rap. Photographs of the bridge and area north and south of the bridge are included as Figures 1 and 2.

Tidal Regime

Predicted tide range was determined using the Portland Tide Station data, and the New England Coastline Tidal Flood Survey. The closest predicted tide station to the site was the Chebeague Point station, which is 2.0 miles from LJI. Because of this small distance the difference in tidal regime should be minor. The correction factor for both the low and high tide was 0.99. Multiplying this correction factor to the Portland station information provides the following estimates.

	Mean Low Low Water (MLLW), NAVD88	Mean High High Water (MHHW), NAVD88	Estimated Tide Range
Portland Gage	-5.3 feet	4.61 feet	9.8 feet
LJI site	-5.25 feet	4.56 feet	9.8 feet

Tide Data

To determine whether or not there was a tidal difference between the north and south sides of the causeway, tide data was recorded for approximately a half day (low tide to low tide) on April 18, 2003. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the bridge opening using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. Key events such as tide direction (peak high or low) were noted. A note log and photo log were kept as well. Following the recording the data was evaluated and graphs showing the observed tide elevations generated. The graph in Figure 3 shows the south and north side water surface elevation and the elevation of the bridge inverts.

Additional Observations

It was observed on April 17, 2003 that the water to the north was very turbid. It appears that this may have been caused by the significant wave energy being produced by the steady north wind

that day may have acted to stir up sediments. The water to the south of the causeway was observed to be less turbid. The difference between the north water and south water was very noticeable.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the south side was reduced by approximately 0.1 feet when compared to the north with no time lag noticeable. This slight difference may have been caused by wind.

Observed Restriction at Low Tide

The only water present at low tide was residual puddles which means both sides completely drained.

Summary of Findings

The data collected for the one event monitored show the north and south side of the causeway experienced a similar tide range.

Discussion

1. If sedimentation to the north of the causeway has increased since the smaller bridge opening was constructed, it may be that flow velocities in certain areas north of the causeway have decreased and this may have resulted in conditions that allow for increased settling of suspended sediment. The data gathered for this study does not provide any information on velocities. Velocity data was not gathered due to the very limited scope of this effort.

2. Further study of the site could include investigations of sediment depths and velocities. It would be possible to use a 2-D hydrodynamic numerical computer model to evaluate how different size openings in the causeway would affect velocities north of the causeway. These types of studies normally cost upwards of $200,000 to perform. Studies are expensive because they require detailed accurate bathymetric data of the area, tide data (one month plus of tide data and velocity measurements), and subsequent computer modeling and analysis by a trained hydraulic engineer.

3. It is not possible without detailed studies and modeling to make any defensible recommendations as to the ways to improve existing conditions at the site. However, aerials from the site appear to show sedimentation north of the causeway. Further studies are recommended to evaluate the effect of the bridge and causeway on the aquatic resources in this area.

North View

South View

April 2003 Littlejohn Island Site, Yarmouth, ME Figure 1

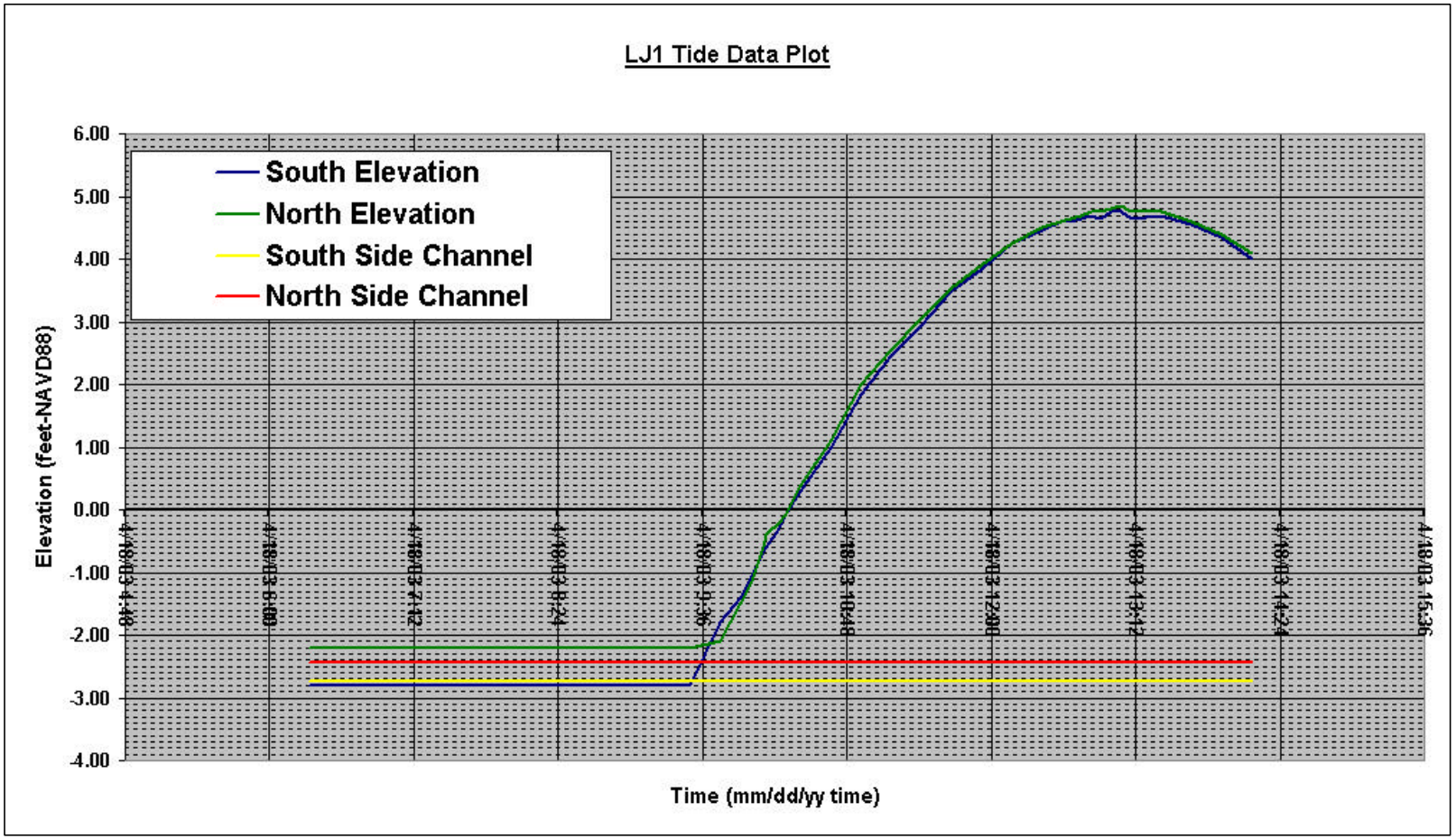
North View

South View

April 2003

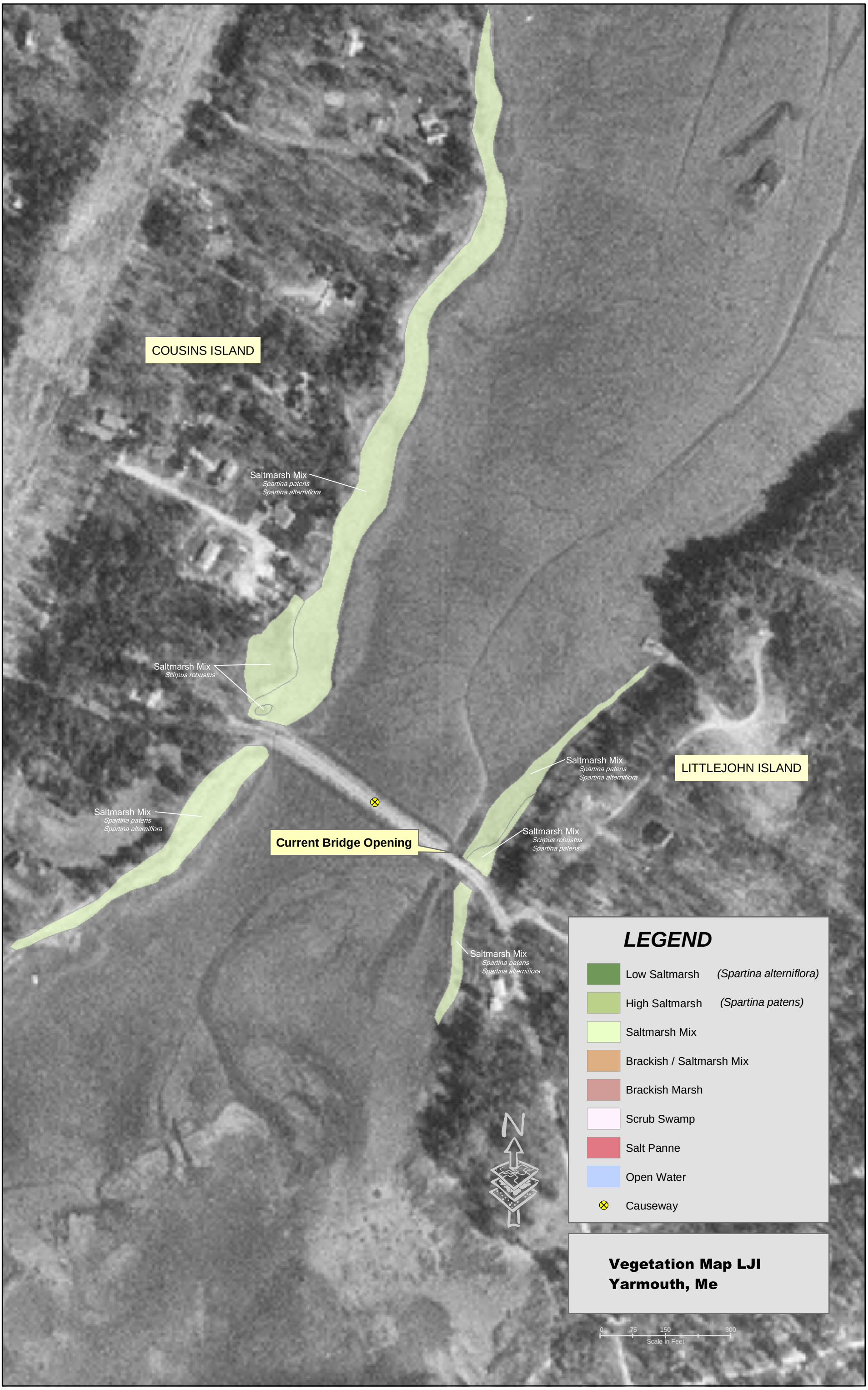
Littlejohn Island Site, Yarmouth, ME

Figure 2



April 2003 Littlejohn Island Site, Yarmouth, ME

Figure 3


COUSINS ISLAND
Saltmarsh Mix
Spartina patens
Spartina alterniflora
Saltmarsh Mix
Scirpus robustus
Saltmarsh Mix
Spartina patens
Spartina alterniflora
Saltmarsh Mix
Spartina patens
Spartina alterniflora
Current Bridge Opening
Saltmarsh Mix
Scirpus robustus
Spartina patens
LITTLEJOHN ISLAND
Saltmarsh Mix
Spartina patens
Spartina alterniflora
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Causeway
N
Vegetation Map LJI
Yarmouth, Me
0 75 150 300
Scale in Feet

Appendix 4

ORI 03

APPENDIX 4

Site: ORI 3

Water Body Stream/ Name: Doughty Cove
Town: Harpswell, Maine
USGS Quadrangle Name: Orrs Island
Estimated Wetland Area Above Crossing: 29 acres

General

The culvert is under a town road named Long Reach Lane, which can be reached by taking the first right after Harpswell Auto Sales.

Vegetation Information

Upstream and downstream of the road the marsh was a mixture of typical salt marsh vegetation. A very small amount of cattail was noted along the edge of the salt marsh downstream of the culvert and slightly higher amount of cattail was noted upstream of the culvert.

Salinity

Salinity was measured once at the culvert. This measurement was on a clear day preceded by several rainy days. Salinity was observed to be 5 ppt. This low reading is probably a result of freshwater runoff due to proceeding days of rain.

Culvert Information

The culvert is a concrete culvert, approximately 25 feet in length with an inside diameter of 3 feet. The marsh side of the culvert has an invert of 1.34' NAVD88. The ocean side of the culvert has an invert of 1.62'. The culvert is in good condition but there is some erosion around the culvert headwall that may be due to over topping during storm tides

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on October 8, 2002. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in PHI14 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 1.40 feet with a time lag of approximately 40 minutes for this magnitude of tidal event. As the tidal plot shows, the high tide elevation is substantially reduced. This is true for the low tide elevations as well. It is evident that the culvert causes a significant reduction in tidal range.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 5.0 feet lower than the marsh side. As mentioned the culvert is causing a significant reduction in tidal range in the marsh. The marsh side water surface elevation never makes it close to the culvert invert. The marsh seems to be healthy, but its vertical range has certainly been reduced due to the tide range reduction. Also, high velocities through the culvert were observed. If this culvert were replaced in the future hydraulic modeling could be used to properly size the culvert to increase tide range and reduce the current speeds.

Flooding Impacts

The ORI 03 vegetation map shows the area to be primarily undeveloped and wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit. However, before tidal flow is increased at the site, a careful review of the adjacent area and existing elevations is required to identify any potential flooding impacts.

Summary of Findings

1. Providing a larger opening at the site would increase the tide range in the marsh which may increase the amount of saltmarsh and the overall health of the marsh by providing increased tidal inundation at high tide and drainage at low tide. Computer modeling of the culvert and the marsh would be needed to determine the correct size.

2. The Bowdoin Study at the site noted that the tide range on the upstream side of the culvert is significantly less then the range on the dowstream side. This may be related to the relative elevations of the upstream and downstream marsh (the salt marsh above the roadway appeared to be at a higher elevation than the salt marsh downstream), the channel inverts, and the culvert capacity. This site is one to continue to examine and if invasive vegetation begins to establish itself, ME DOT may wish to consider providing a larger culvert for increased tidal exchange.

Site ORI 03 – Ocean side of culvert under Long Reach Lane.

Site ORI 03 – Marsh side of culvert under Long Reach Lane.

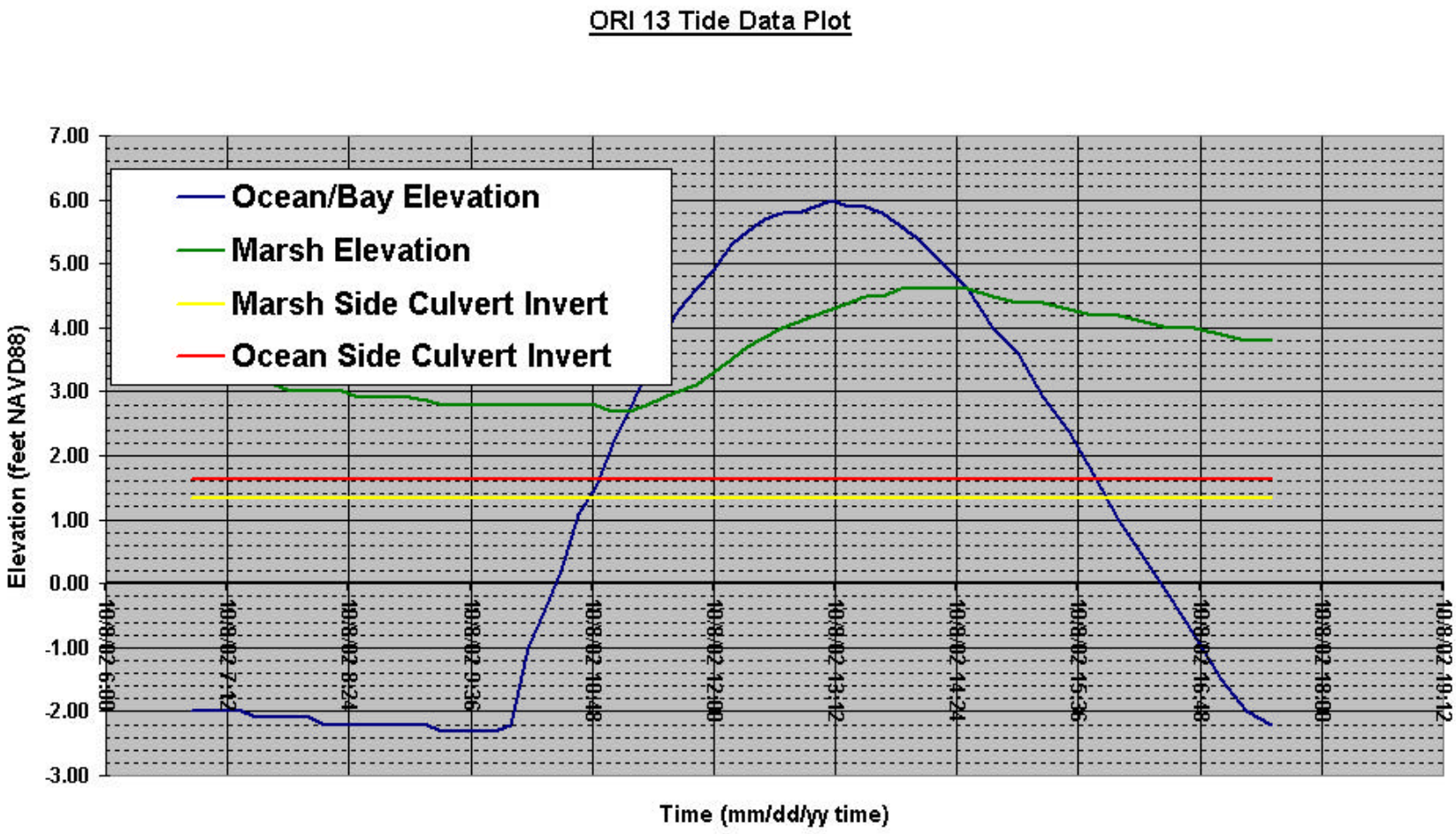
Site ORI03 – Typical view marsh side of Long Reach Lane.

Site ORI03 – Typical view of ocean side of Long Reach Lane.

October 2002

ORI 03 Harpswell, Maine

Figure 2


ORI 13 Tide Data Plot
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Culvert Invert
Ocean Side Culvert Invert
Elevation (feet NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
10/8/02 6:00
10/8/02 7:12
10/8/02 8:24
10/8/02 9:36
10/8/02 10:48
10/8/02 12:00
10/8/02 13:12
10/8/02 14:24
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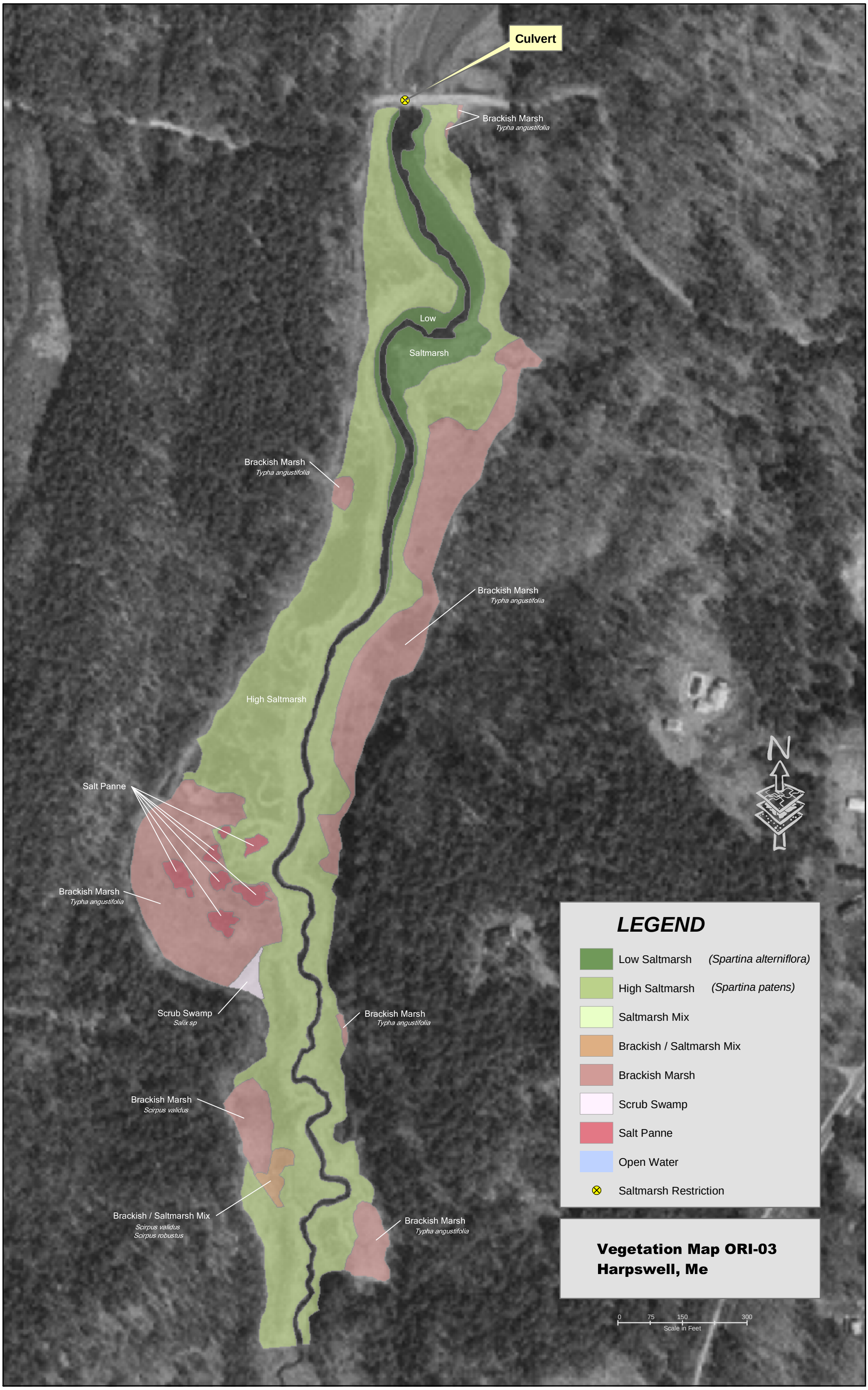
10/8/02 16:48
10/8/02 18:00
10/8/02 19:12
Time (mm/dd/yy time)


Culvert
Brackish Marsh
Typha angustifolia
Low
Saltmarsh
Brackish Marsh
Typha angustifolia
Brackish Marsh
Typha angustifolia
High Saltmarsh
Salt Panne
Brackish Marsh
Typha angustifolia
Scrub Swamp
Salix sp
Brackish Marsh
Typha angustifolia
Brackish Marsh
Scirpus validus
Brackish / Saltmarsh Mix
Scirpus validus
Scirpus robustus
Brackish Marsh
Typha angustifolia
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map ORI-03
Harpswell, Me
0
75
150
300
Scale in Feet

Appendix 5

PHI 01

APPENDIX 5

Site: PHI 01

Water Body Stream/Name: Morse River
Town: Phippsburg, Maine
USGS Quadrangle Name: Phippsburg, Maine
Estimated Wetlands Area Above Crossing: 9 acres estimated

General

The culvert at the site is located under State Route 209. See site photographs included as Figures 1 and 2. It is located about 3 miles upstream from the Atlantic Ocean on the Morse River.

Vegetation Information

A site visit was made on May 12, 2003. The site was mixture of high salt marsh vegetation types with a small patch of *Phragmites* evident in the south east corner of the site.

Salinity

Salinity was measured at the culvert on May 12 on an outgoing tide. The measurement was made with a hand held refractometer and indicated freshwater conditions. Due to the presence of salt marsh grasses at the site is anticipated that measurements on an incoming tide would yield higher salinities.

Culvert Information

The culvert is an old granite stone box culvert. Its could not be fully seen due to the elevation of the tide at the time of the site visit, but it appears that it may be in need of repair. Considerable erosion on the ocean side of the culverts was noted. The marsh side of the culvert has an invert of 2.00 feet NAVD88 with the rough dimensions of 5 feet high by 2.0 feet wide. The ocean side of the culvert has an invert of 0.58 feet NAVD88 but the opening was too irregular to take dimensions. The culvert has a length of 33 feet and runs perpendicularly underneath the road.

Tidal Regime

Predicted tide range was determined using the Portland Tide Station data, and the New England Coastline Tidal Flood Survey. The closest prediceted tide station to the site was

the Small Point Harbor station which is 2 miles from PHI 01. Because of this small distance the diffeernce in tidal regime should be minor. The correction factor for both the low and high tide for the Small Point station from the Portland Station was 0.97. Multiplying this correction factor to the Portland stations MLLW (-5.3 feet NAVD88) and MHHW (4.61 feet NAVD88) results in a tide range of 9.6 feet NAVD88 (-5.1 feet to 4.5 feet NAVD88).

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on April 18, 2003. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in PHI 01 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 0.10 feet with minimal time lag between the ocean side and marsh side peaks.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 2.0 feet lower than the marsh side. The marsh tide range is 60 percent of the ocean tide range.

Flooding Impacts

The area surrounding the marsh is primarily wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit. However, if measures to increase tidal range are considered at the site then a careful review of the adjacent area and existing elevations is required to identify any potential flooding concerns.

Summary of Findings

1. The culvert may be in need of some repair. The ocean side banks show noticeable erosion.

2. Providing a larger opening at the site is not likely to significantly increase the height of the tide in the upstream marsh, but may improve marsh drainage. This would cause a larger tide range in the marsh (all gains would be at low tide). Further investigations including computer modeling of the culvert and the marsh would be needed if it is desired to analyze alternative culvert sizes and inverts for environmental improvements.

3. Drainage might be improved by adding a second culvert at a lower elevation.

Site PHI 01 - Ocean side of Culvert at Route 209

Site PHI 01 - View marsh side of culvert at Route 209

Figure 1

April 2003

PHI 01, Phiipsburg, Maine

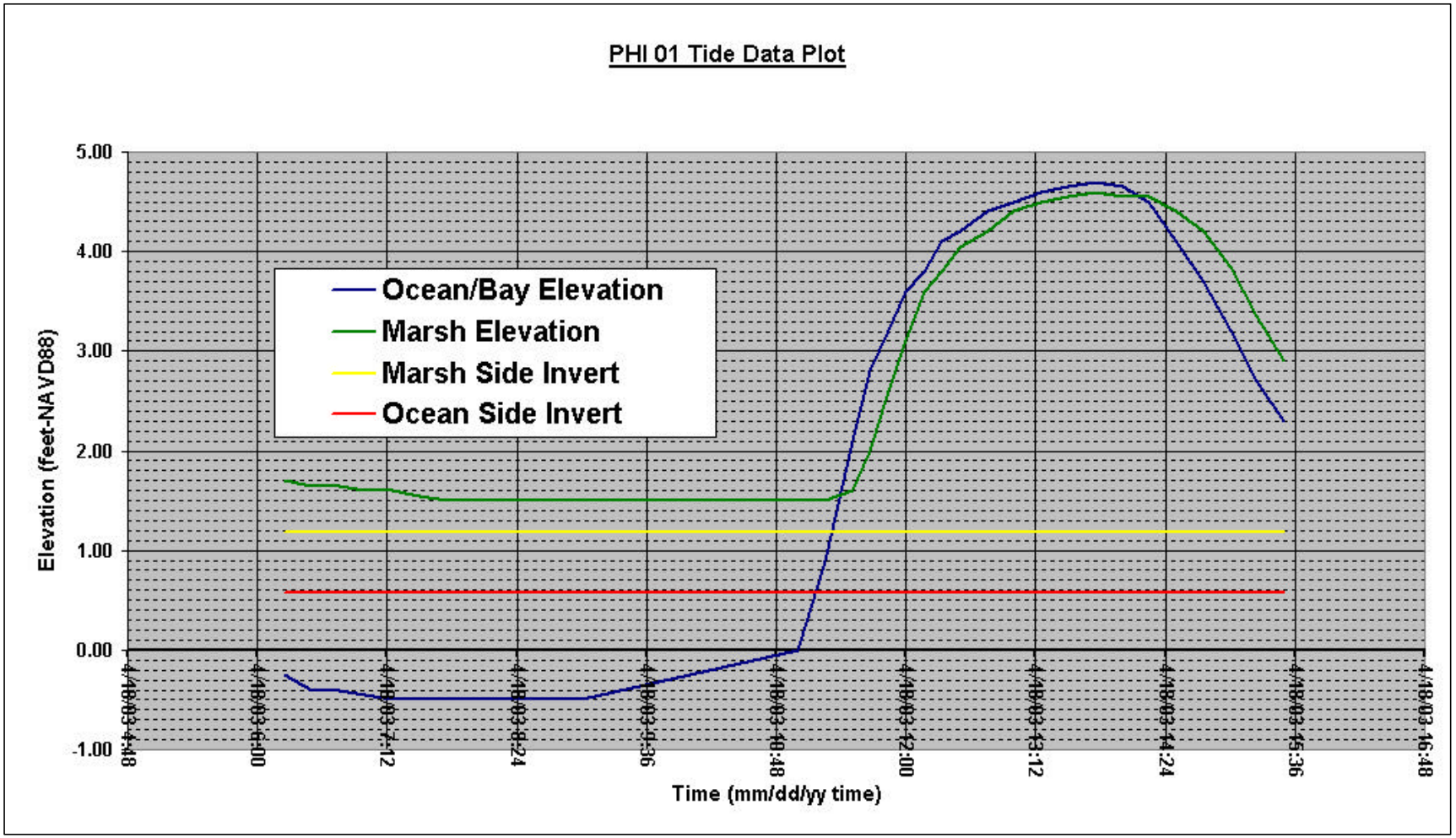
Site PHI 01 - Typical view on Ocean side of Route 209

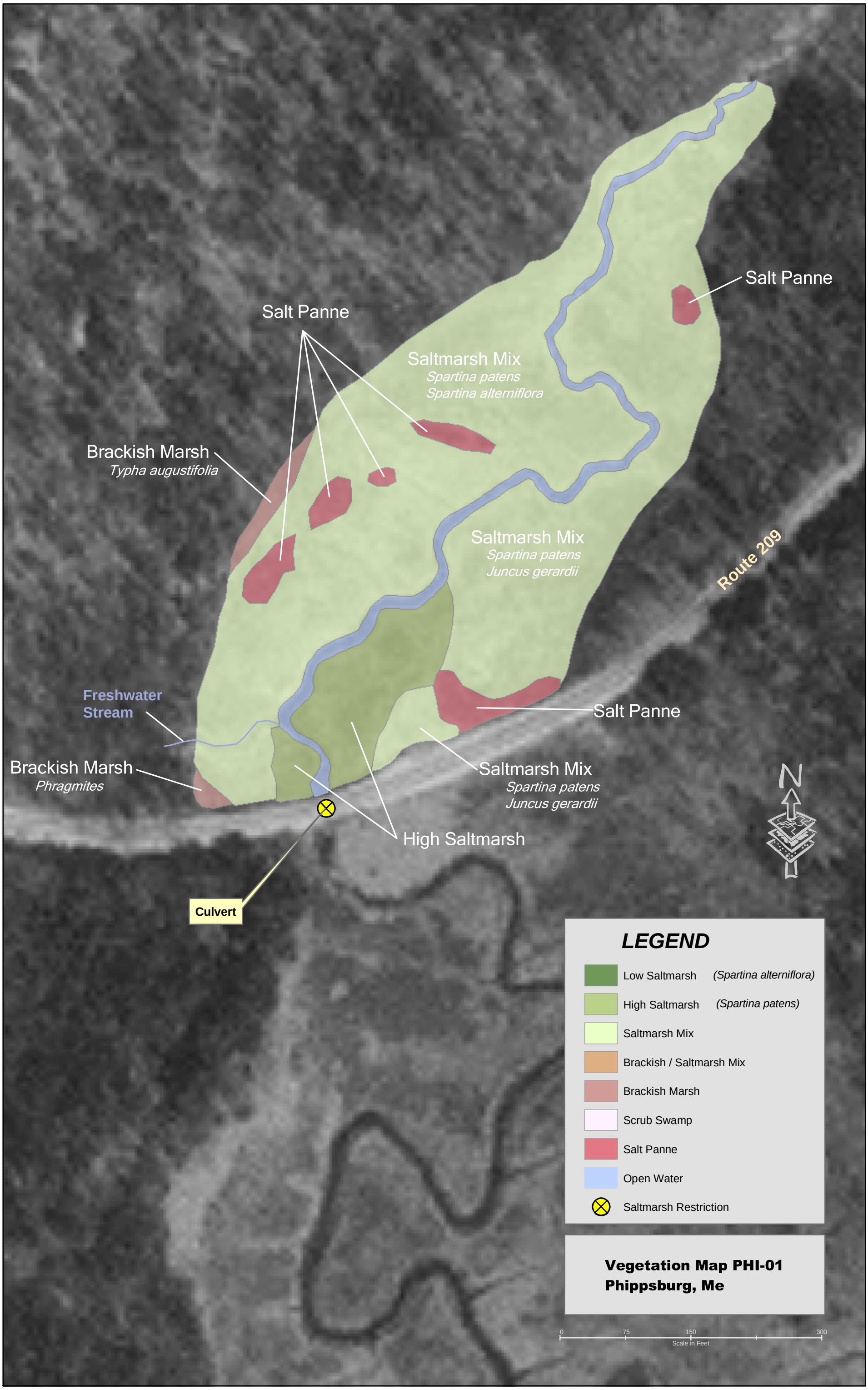
Site PHI 01 - Typical view on Marsh side of Route 209

April 2003

PHI 01, Phiipsburg, Maine

Figure 2


PHI 01 Tide Data Plot
Elevation (feet-NAVD88)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Invert
Ocean Side Invert
4/18/03 4:48
4/18/03 6:00
4/18/03 7:12
4/18/03 8:24
4/18/03 9:36
4/18/03 10:48
4/18/03 12:00
4/18/03 13:12
4/18/03 14:24
4/18/03 15:36
4/18/03 16:48
Time (mm/dd/yy time)


Salt Panne
Salt Panne
Saltmarsh Mix
Spartina patens
Spartina alterniflora
Brackish Marsh
Typha augustifolia
Saltmarsh Mix
Spartina patens
Juncus gerardii
Route 209
Freshwater Stream
Salt Panne
Brackish Marsh
Phragmites
Saltmarsh Mix
Spartina patens
Juncus gerardii
High Saltmarsh
Culvert
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map PHI-01
Phippsburg, Me
0
75
150
300
Scale in Feet

Appendix 6

PHI 14

APPENDIX 6

Site: PHI14

Water Body Stream/ Name: Kennebec River
Town: Arrowsic, Maine
USGS Quadrangle Name: Phippsburg
Estimated Wetland Area Above Crossing: 26 acres

General

Culvert is located under Route 127 (state road) in Arrowsic, Maine just past Fisher Eddie Road. The site is located about 7 miles upstream on the Kennebec River from the Atlantic. This site should not be confused with the privately owned wildlife management area just to the north of this site that was identified as a restoration site in the 1998 report by Lisa Windhausen.

Vegetation Information

Vegetation both downstream and upstream of appears to be dominated by cattail *Typha* spp. The cattail downstream of Route 127 may reflect the lower salinity due mixing of the freshwater drainage of the Kennebec River and the tidal inflow up the Kennebec River from the ocean.

Salinity

Salinity was measured on an incoming tide at the site on October 2002. The measurement was 12 parts per thousand (ppt). In June of 2002 salinity was measured on an outgoing tide at 4 ppt. This lower measurement was on a clear day preceded by several rainy days. However, both measurements indicate salinity at the site is low compared to typical salt marsh areas with salinities greater than 20 ppt.

Culvert Information

The culvert is corrugated metal pipe with a 5 ft. diameter and it runs under Route 127 for 55 feet. The culvert was replaced in the last 5 years and is in good condition. The marsh side of the culvert has an invert of -1.42' NAVD88. The ocean side of the culvert has an invert of Invert: -1.98'. The downstream end of the culvert is under water during high tide. The channel downstream of the culvert is about 20-30' wide while the channel upstream of the culvert is about 10' wide.

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on October 8, 2002. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. Key events such as tide direction (peak high or low) were noted. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in PHI14 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 0.80 feet with a time lag of approximately a half hour (depending on location in tide signal) for this magnitude of tidal event.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 1.0 foot lower than the marsh side. Based on this observation and the high tide observation, the culvert is causing a moderate tide restriction. The marsh tide range was 75% of the ocean range.

Flooding Impacts

The aerial photograph shows the area to be primarily undeveloped and wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit. However, before tidal flow is increased at the site, a careful review of the adjacent area and existing elevations is required to identify any potential flooding impacts.

Summary of Findings

1. The culvert is in good condition with no apparent flow/scour issues evident.

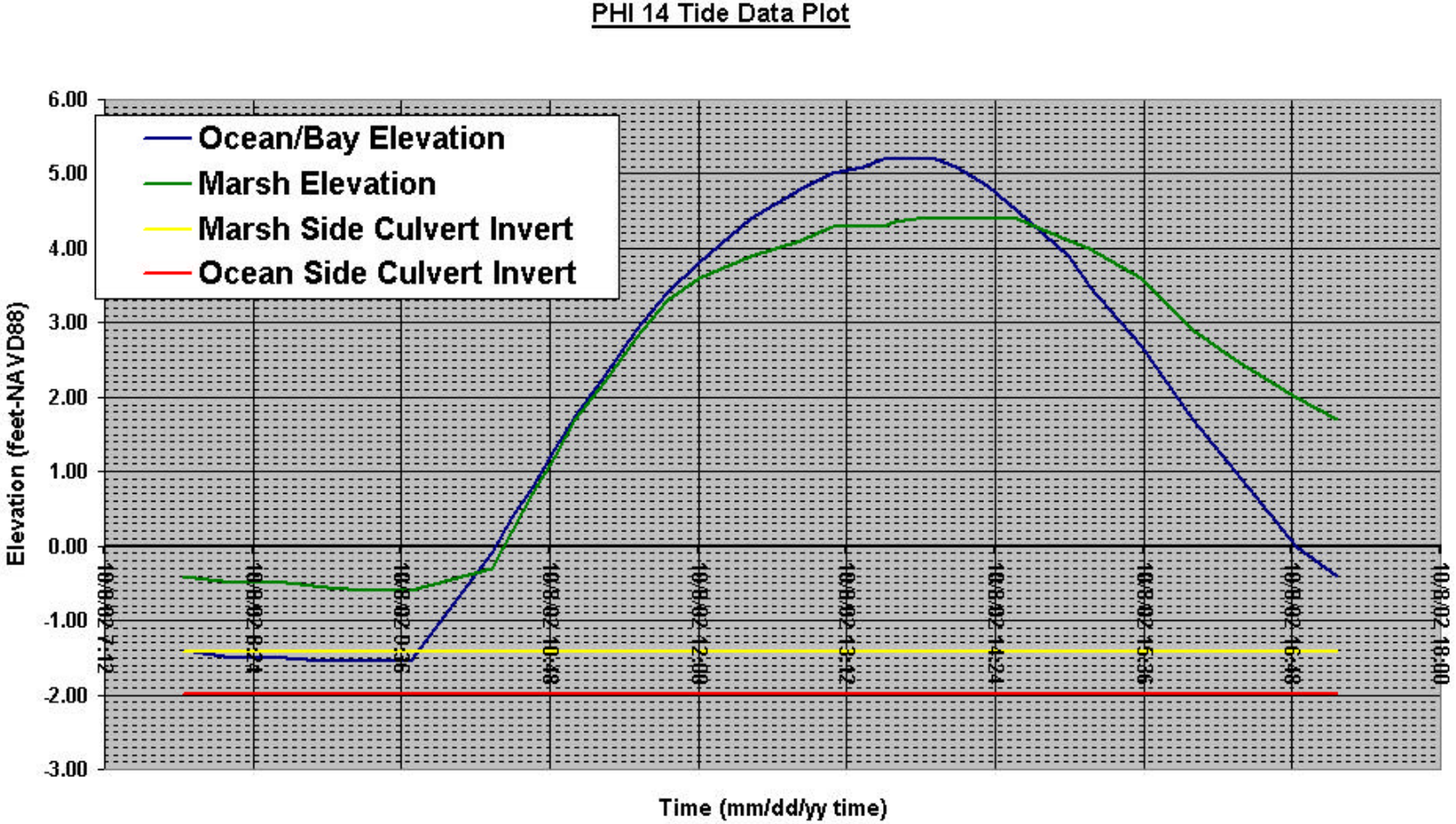
2. The marsh tide was reduced by 25 percent of the ocean side tide range for the event monitored. A larger opening would increase the tide range to some degree, which would increase tidal inundation at high tide. However, due to the low salinities at the site it may be unlikely that salt marsh can be restored. Some investigation of the influence of the Kennebec River on this area would be needed. Further investigation of how salinities vary over the course of the year downstream of the site would be useful in predicting the success of attempts to restore salt marsh to this area.

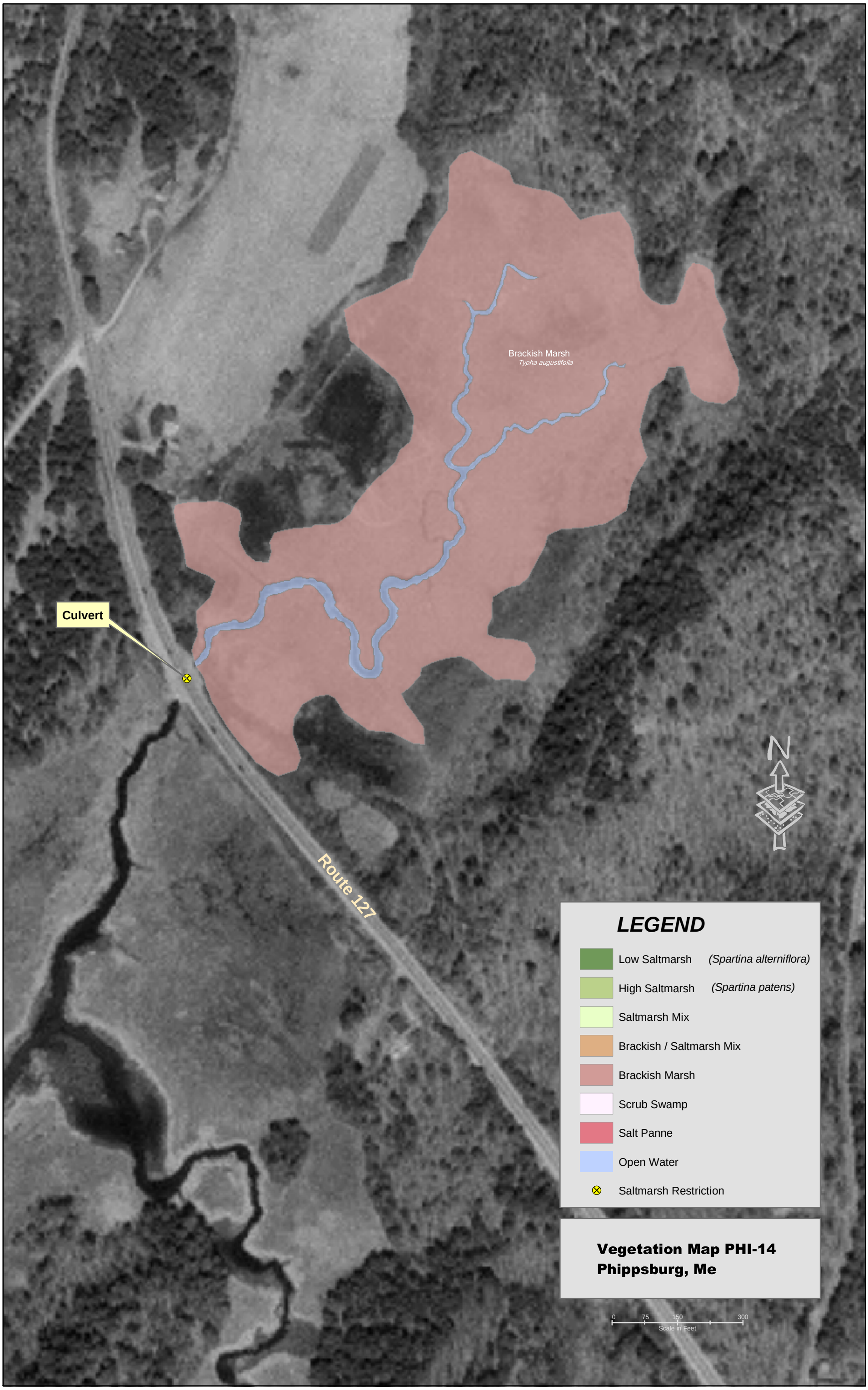
Site PHI 14 - Ocean side of Route 127 culvert

Site PHI 14 - Marsh side culvert

PHI 14- Typical view of ocean side marsh

PHI 14 – Typical view of marsh side


PHI 14 Tide Data Plot
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Culvert Invert
Ocean Side Culvert Invert
Elevation (feet-NAVD88)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
10/8/02 7:12
10/8/02 8:24
10/8/02 9:36
10/8/02 10:48
10/8/02 12:00
10/8/02 13:12
10/8/02 14:24
10/8/02 15:36
10/8/02 16:48
10/8/02 18:00
Time (mm/dd/yy time)


Brackish Marsh
Typha augustifolia
Culvert
Route 127
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map PHI-14
Phippsburg, Me
0 75 150 300
Scale in Feet

Appendix 7

PHI 17

APPENDIX 7

Site: PHI17

Water Body Stream/ Name: Back River
Town: Arrowsic, Maine
USGS Quadrangle Name: Phippsburg
Estimated Wetland Area Above Crossing: 7 acres

General

Location PHI 17 is a culvert located under Indian Rest Road (town road). The north end of the marsh borders on Route 127. The marsh system forms an "oxbow" off the Back River. The downstream portion has unrestricted access to the Back River. Only the upstream portion is controlled by the culvert at Indian Rest Road.

Vegetation Information

Both downstream and upstream of the culvert at Location 17 was a mixture of salt marsh grasses. Some cattails were present along the north and south edges of the marsh.

Salinity

Salinity was measured in October 2002 at 20 ppt on an incoming tide. Previously in June 2002 salinity was observed to be 10 ppt. This measurement was on a clear day preceded by several rainy days. The lower salinity reading is probably a result of freshwater runoff due to proceeding days of rain.

Culvert Information

The culvert under Indian Rest Road is a steel corrugated culvert, approximately 55 feet in length with a diameter of 3 feet. The marsh side of the culvert has an invert of 1.86' NAVD88. The ocean side of the culvert has an invert of 0.42' NAVD88. The invert of the downstream end of the culvert is above the creek channel invert. The culvert appeared to be in good condition.

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on October 8, 2002. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. Key events such as tide direction (peak high or low) were noted.

The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in PHI14 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 1.30 feet with a time lag of approximately an hour and ten minutes for this magnitude of tidal event. As the tidal plot shows the high tide elevation is substantially reduced. This is true for the low tide elevations as well. It is evident that the culvert causes a significant reduction in tidal range.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 4.3 foot lower than the marsh side. As mentioned, the culvert is causing a significant reduction in tidal range in the marsh. However, the marsh channel inverts are several feet above the downstream channel invert and also contributes to the observed difference. High velocities through the culvert were observed.

Flooding Impacts

Land-use adjacent to the marsh appears to be primarily wooded. There is one private residence and dock located adjacent to the downstream end of the culvert. Since the residence is down stream there should be no flooding impacts.

Summary of Findings

1. The culvert is good condition with some possible scour evident.

2. Providing a larger opening at the site would increase the tide range in the marsh which may increase the amount of marsh and the health of the marsh by providing increased tidal inundation at high tide. Computer modeling of the culvert and the marsh would be needed to determine the correct size.

3. Drainage from the marsh, if desired, could be improved by adding a second culvert at a lower elevation.

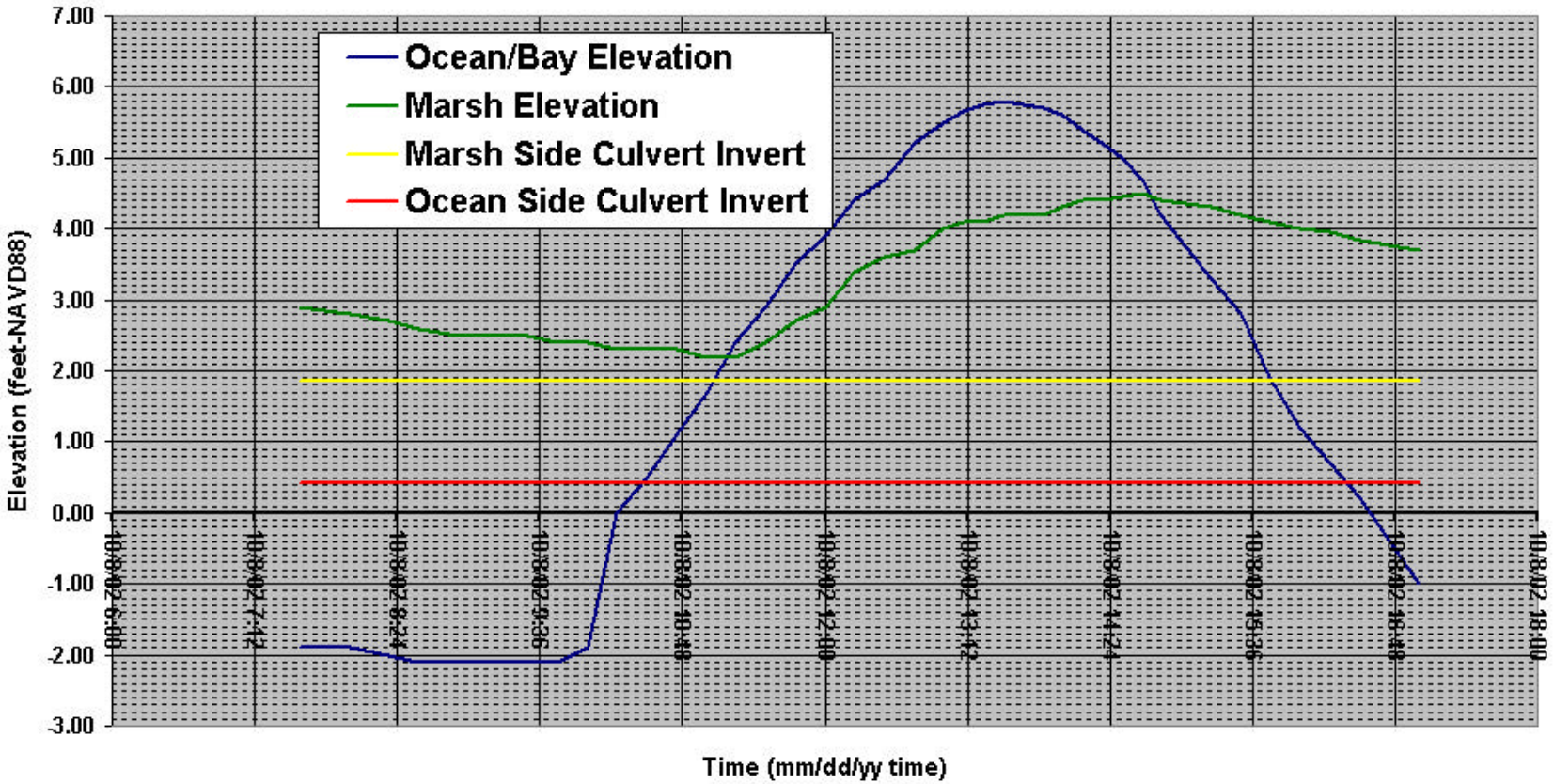
Site PHI17A – Ocean side of Indian Rest Road culvert.

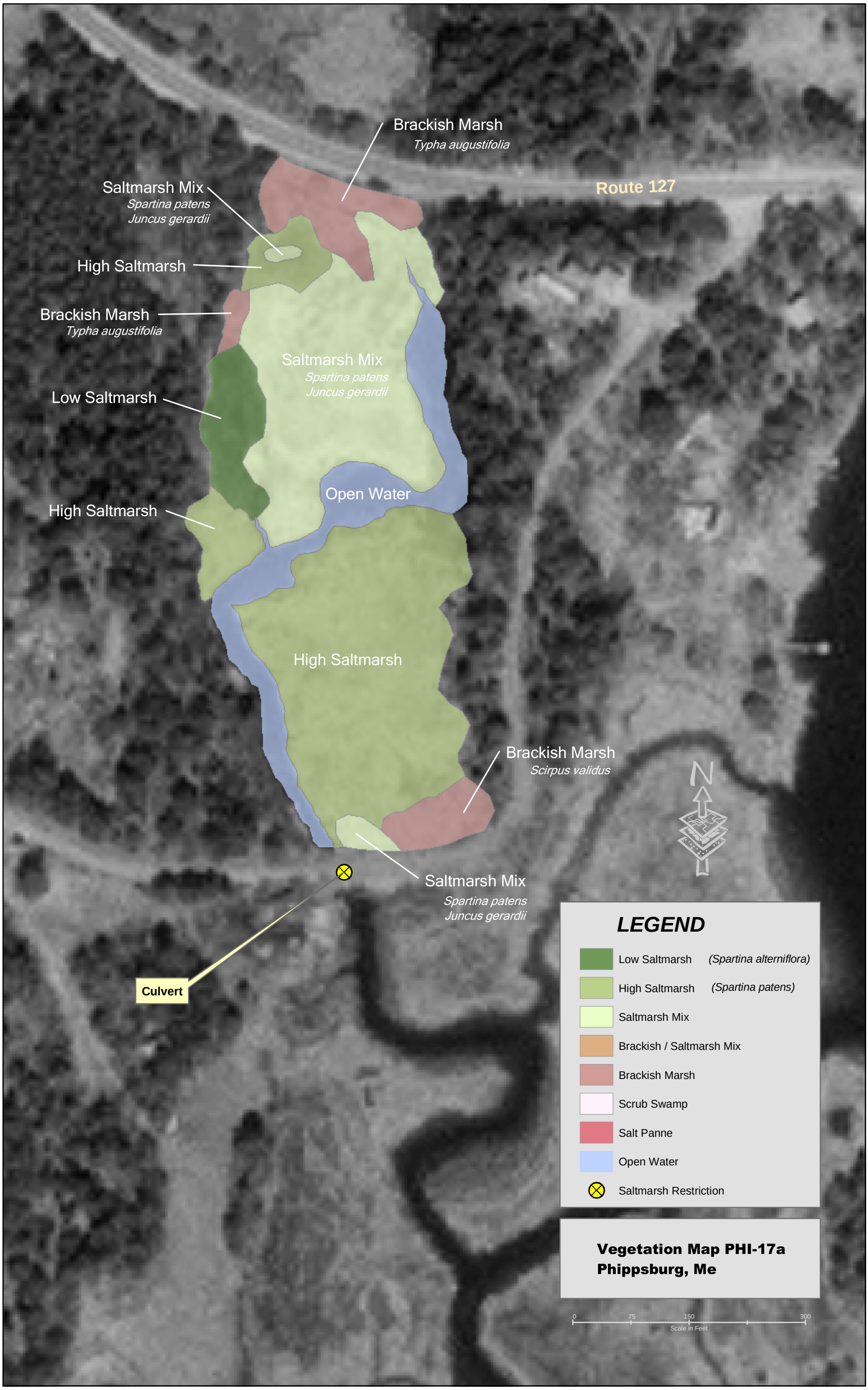
Site PHI17A – Marsh side of Indian Rest Road culvert.

Site PHI 17 – Typical view of marsh looking towards Route 127

.

Site PHI 17 – Typical view of marsh on ocean side of Indian Rest Road.


PHI 17A Tide Data Plot
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Culvert Invert
Ocean Side Culvert Invert
Elevation (feet-NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
10/8/02 6:00
10/8/02 7:12
10/8/02 8:24
10/8/02 9:36
10/8/02 10:48
10/8/02 12:00
10/8/02 13:12
10/8/02 14:24
10/8/02 15:36
10/8/02 16:48
10/8/02 18:00
Time (mm/dd/yy time)


Brackish Marsh
Typha augustifolia
Route 127
Saltmarsh Mix
Spartina patens
Juncus gerardii
High Saltmarsh
Brackish Marsh
Typha augustifolia
Saltmarsh Mix
Spartina patens
Juncus gerardii
Low Saltmarsh
Open Water
High Saltmarsh
High Saltmarsh
Brackish Marsh
Scirpus validus
N
Saltmarsh Mix
Spartina patens
Juncus gerardii
Culvert
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map PHI-17a
Phippsburg, Me
0
75
150
300
Scale in Feet

Appendix 8

PHI 102

APPENDIX 8

Site: PHI 102

Water Body Stream/ Name: Mouth Kennebec River near Popham Beach
Town: Phippsburg, Maine
USGS Quadrangle Name: Phippsburg, Maine
Estimated Wetland Area Above Crossing: 3 acres estimated

General

The two culverts are located under State Route 209 near Popham Beach in Phippsburg, Maine. See Figures 1 and 2.

Vegetation Information

A site visit was made on May 12, 2003 and general vegetation types identified. The area was a mixture of salt marsh vegetation with *Phargmites* and cattail present on the west side of the marsh.

Salinity

Salinity was measured at the culvert on May 12 on an outgoing tide. Salinity was 7 parts per thousand (ppt) and is indicative of freshwater input to the area. It is anticipated that measurements on an in-coming tide would result in salinities in the 20 to 30 ppt range.

Culvert Information

There are two 24-inch diameter PVC culverts running perpendicular to the road. The culverts appear to be in good condition with no problems evident. The culverts were designated as the east culvert and the west culvert. The east culvert had a marsh side invert of 3.44 feet NAVD88 and the west culvert had a marsh side invert of 2.73 feet NAVD88. The east culvert and west culvert had ocean side inverts of 2.45 feet and 2.21 feet, respectively. The culverts were measured to be 48.5 feet long.

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on April 18, 2003. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. The plot showing the ocean side elevation, the marsh side

elevation, and the elevation of the culvert inverts can be seen in PHI 102 tide data plot Figure 3.

Observed Restriction at High Tide

The figure shows that the maximum tide height on the marsh side was the same as the ocean side for the event monitored.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 1.55 feet lower than the marsh side. Observed marsh side low tide water depth was about six inches to one foot deep. The marsh did not drain completely. Marsh drainage on the low tide could be improved by removing vegetation and sediment that has grown/accumulated on the marsh side of the culverts. This "feature" acts as a weir and limits the out flow on an ebb tide.

Flooding Impacts

The area surrounding the marsh is primarily wooded. There were several structures noted that were on the marsh side of the road. If any work was proposed at the site, some investigation of these areas would be needed to ensure increased flooding would not occur.

Summary of Findings

1. The culverts' condition was good with no problems evident.

2. It does not appear that larger culverts are needed to increase the high tide. The high tide elevations in the marsh match the oceans side elevation for the event monitored. However, drainage appears to be impacted by the vegetation and sediment build-up at the culverts. Clearing this area would improve marsh drainage at low tide. Before this is considered, an ecological evaluation would be needed to compare the benefit of the existing pounded area near the culvert to an alternative inter-tidal area.

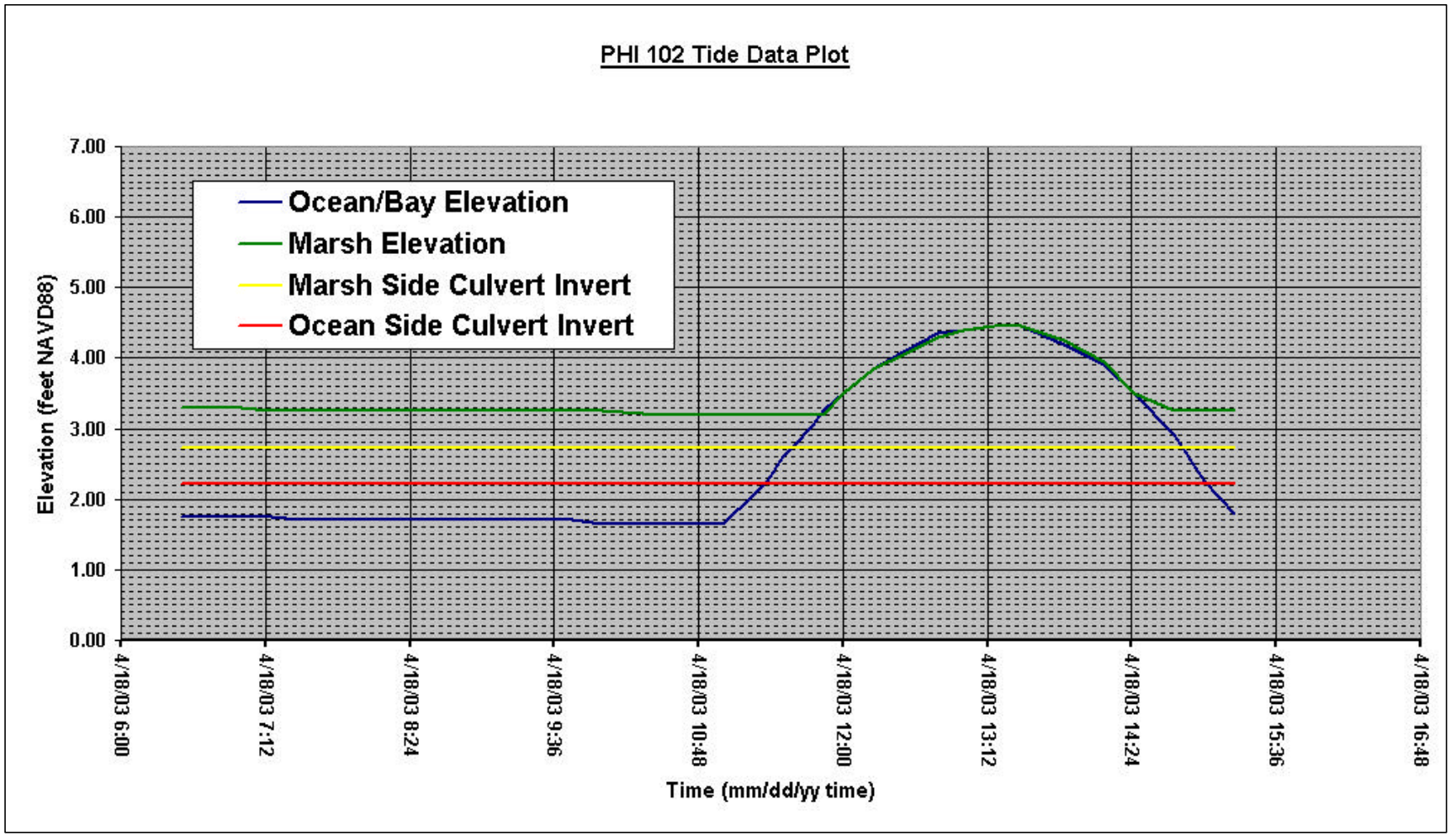
3. There was some *Phragmites* observed along the west side of the marsh.

Site PHI 102 - Ocean side of Culvert at Route 209

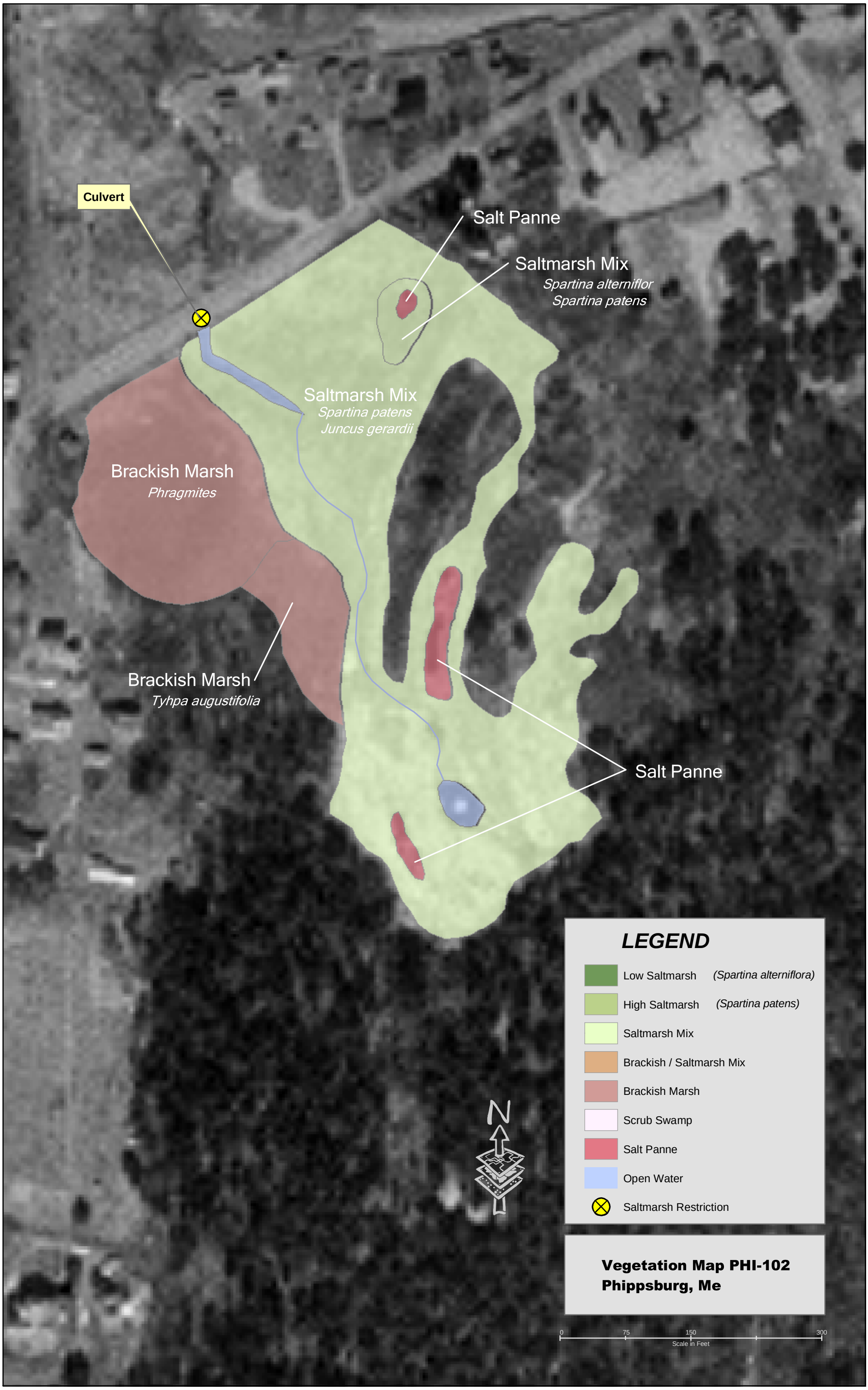
Site PHI 102 - View marsh side of culvert at Route

Site PHI 102 – Typical view ocean side

Site PHI 102 - Typical view on marsh side



APRIL 2003 PHI 102, Phippsburg, ME Figure 3


Culvert
Salt Panne
Saltmarsh Mix
Spartina alterniflor
Spartina patens
Saltmarsh Mix
Spartina patens
Juncus gerardii
Brackish Marsh
Phragmites
Brackish Marsh
Tyhpa augustifolia
Salt Panne
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map PHI-102
Phippsburg, Me
0
75
150
300
Scale in Feet

Appendix 9

SMP 03

APPENDIX 9

Site: SMP03

Water Body Stream/ Name: Totman Cove/Casco Bay
Town: Phippsburg, Maine
USGS Quadrangle Name: Small Point
Estimated Wetland Area Above Crossing: 12 acres

General

The culvert at the site is located under State Route 216, also called Small Point Road. This is a historic culvert documented by Maine Historic Preservation Commission. See photographs of SMP03 in figures 1 and 2.

Vegetation Information

Upstream of the road the marsh was a mixture of salt marsh vegetation with a ponded open water area above culvert. There is a small amount of brackish marsh species (cattail) at certain locations along the marsh edge. (See Vegetation Map SMP03.) Downstream is tidal flat with fringing salt marsh.

Salinity

Salinity was measured at the culvert on October 7 on an incoming tide at 30 parts per thousand. This measurement indicates normal marine salinity in incoming waters is and consistent with observed salt marsh grasses in the upstream marsh.

Culvert Information

The culvert is an old granite stone box culvert that is in poor condition. Flow through the walls of the culvert were witnessed during the tide data recording episode on October 8, 2002. The marsh side of the culvert has an invert of 2.11 feet NAVD88 with the rough dimensions of 1.9 feet high by 3.0 feet wide. There is a small bar upstream of the culvert made of gravel and stone. It is uncertain if this material was placed during construction, placed by individuals to help keep the marshes' low tide water surface elevated, or if the bar formed naturally from material being eroded from the stone culvert. The ocean side of the culvert has an invert of 1.55 feet NAVD88 and has the rough dimensions of 5.0 feet high by 3.0 feet wide. The culvert has a length of 31 feet and runs perpendicularly underneath the road.

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on October 8, 2002. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in the SPM03 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 1.25 feet with a time lag of approximately one hour for this magnitude of tidal event.

Observed Restriction at Low Tide

Looking at the plot the low tide elevation on the ocean side was about 5.40 feet lower than the marsh side. This is due to the fact that the upstream marsh channel and culvert invert is higher than the downstream marsh channel. At low tide, it was observed that about 0.50 feet of water remained in the marsh. It is uncertain why the existing upstream marsh surface and channel are higher in elevation when compared to the ocean side marsh since it is assumed that the marsh was a continuous geographical feature before the road was constructed.

Flooding Impacts

The area surrounding the marsh is primarily wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit. However; before tidal flow is increased at the site, a careful review of the adjacent area and existing elevations is required to identify any potential flooding impacts.

Summary of Findings

1. The culvert is in poor condition and will likely be replaced by ME DOT in the near future.

2. Providing a larger opening at the site would increase the height of the tide in the upstream marsh and maintain the health of the marsh by providing increased tidal inundation at high tide. Computer modeling of the culvert and the marsh would be needed to determine the correct size.

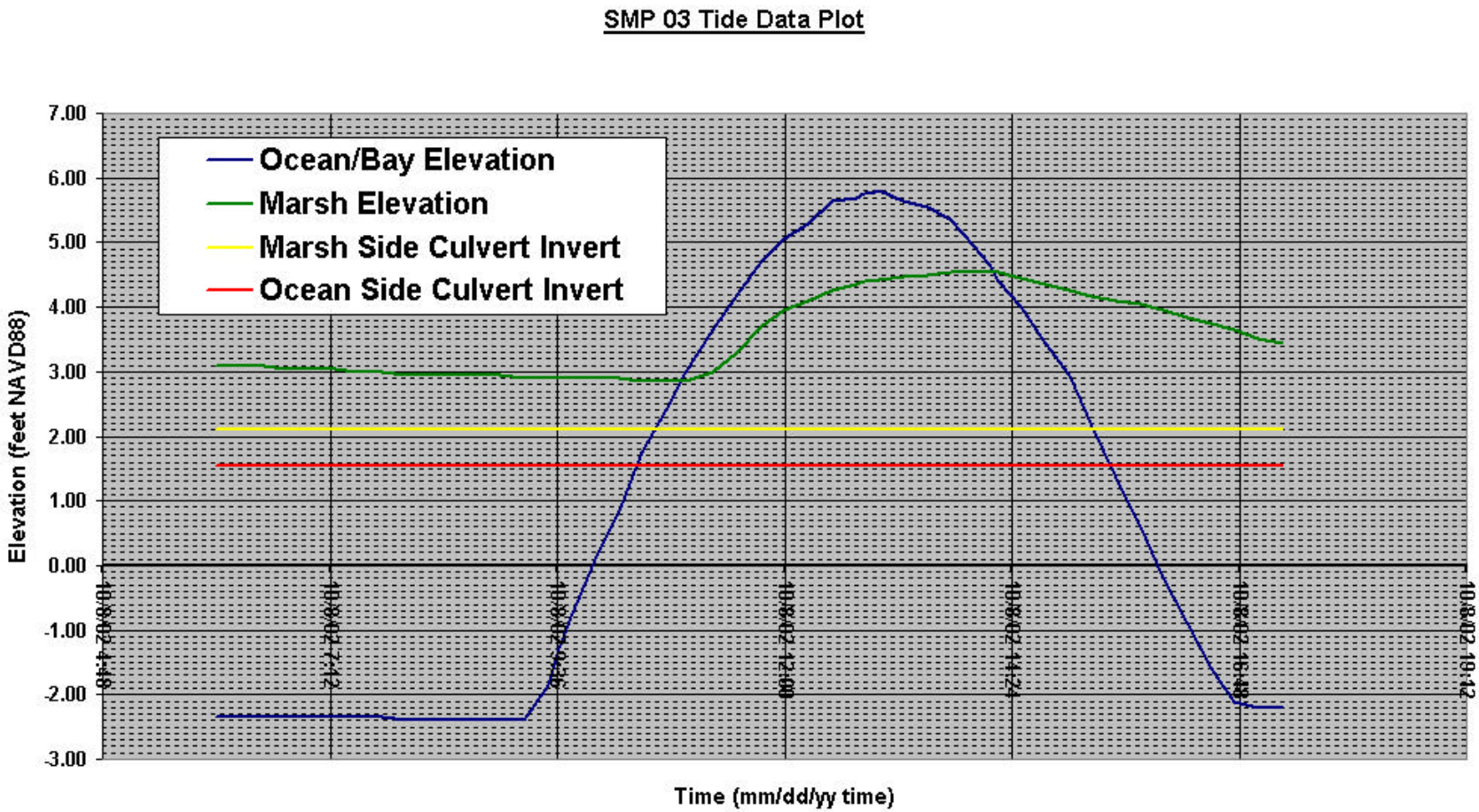
3. Complete draining of the upstream marsh at low tide would involve removing the rock bar, lowering the existing channel and culvert invert. Before this is considered, an ecological evaluation would be needed to compare the benefit of the existing impounded area near the culvert to an alternative inter-tidal area.

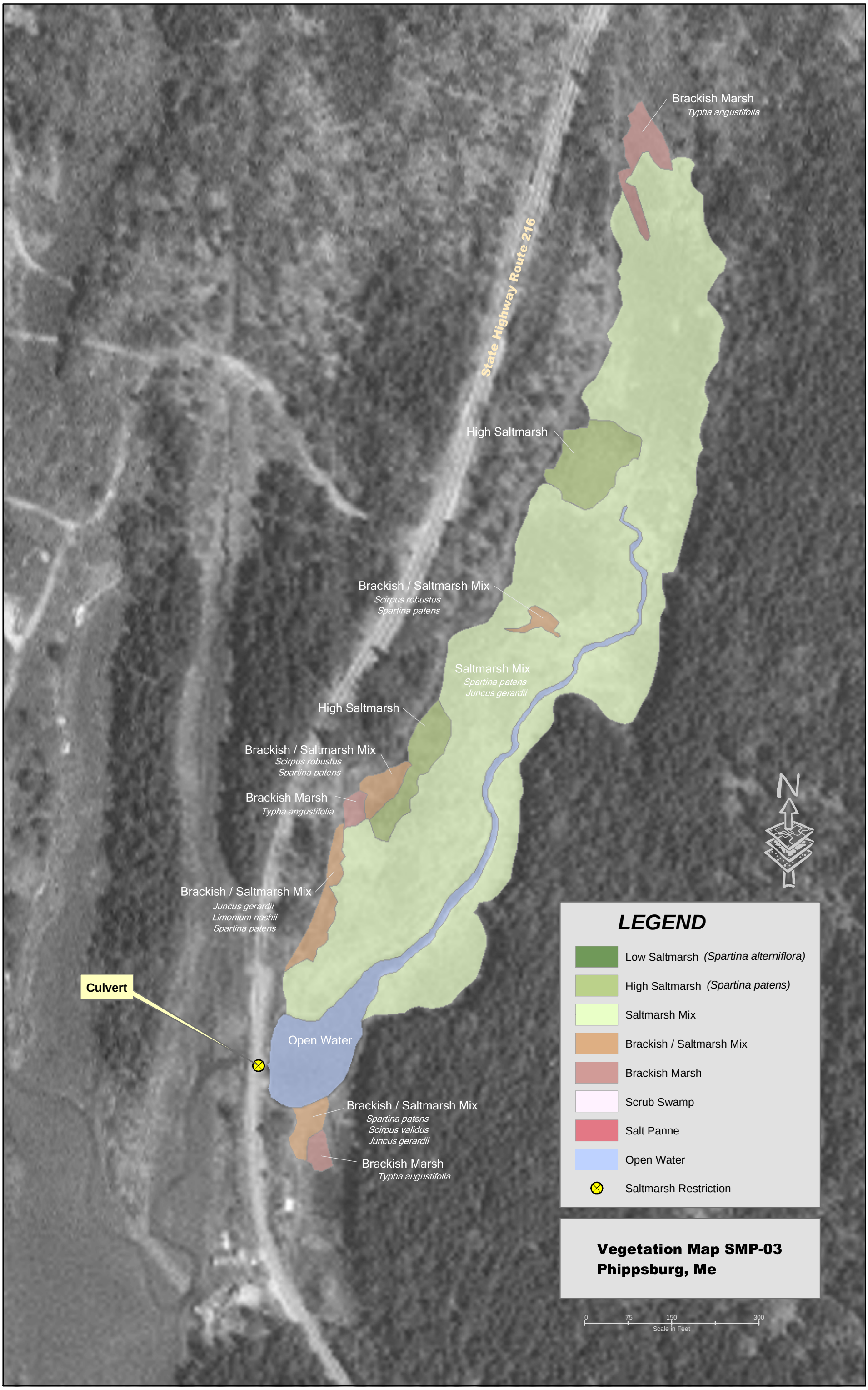
Site SMP 03 - View ocean side of Culvert at Route 216

Site SMP 03 - View marsh side of culvert at Route 216

Site SMP 03 - Typical view on marsh side of Route 216

Site SMP 03 - Typical view on Ocean side of Route 216


SMP 03 Tide Data Plot
Ocean/Bay Elevation
Marsh Elevation
Marsh Side Culvert Invert
Ocean Side Culvert Invert
Elevation (feet NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
10/8/02 1:48
10/8/02 7:12
10/8/02 12:36
10/8/02 18:00
10/8/02 23:24
10/9/02 4:48
10/9/02 10:12
Time (mm/dd/yy time)


Brackish Marsh
Typha angustifolia
State Highway Route 216
High Saltmarsh
Brackish / Saltmarsh Mix
Scirpus robustus
Spartina patens
Saltmarsh Mix
Spartina patens
Juncus gerardii
High Saltmarsh
Brackish / Saltmarsh Mix
Scirpus robustus
Spartina patens
Brackish Marsh
Typha angustifolia
Brackish / Saltmarsh Mix
Juncus gerardii
Limonium nashii
Spartina patens
Culvert
Open Water
Brackish / Saltmarsh Mix
Spartina patens
Scirpus validus
Juncus gerardii
Brackish Marsh
Typha augustifolia
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map SMP-03
Phippsburg, Me
0
75
150
300
Scale in Feet

Appendix 10

WPT 17

APPENDIX 10

Site: WPT17

Water Body Stream/ Name: Squam Creek
Town: Westport, Maine
USGS Quadrangle Name: Westport
Estimated Wetland Area Above Crossing: 37 acres

General

The culvert runs under a town road which is located west off State Route 144 south. See Figures 1 and 2.

Vegetation Information

Upstream of the road the marsh was a mixture of typical salt marsh vegetation with some very minor amount of *Phragmite*s on the right side and a very small amount of cattail vegetation along upland edge. Downstream of the road was an open embayment.

Salinity

Salinity was measured once at the culvert. This measurement was on a clear day preceded by several rainy days. Salinity was observed to be 10 ppt. This lower reading is probably a result of freshwater runoff due to proceeding days of rain.

Culvert Information

The culvert is a steel corrugated culvert, approximately 50 feet in length. The marsh side of the culvert has an invert of -0.16' NAVD88 with a 5-foot diameter. The ocean side of the culvert has an invert of -0.60' NAVD88 and is roughly 5.5' high by 4.5' wide (pipe has been flattened). Visually it appears that the culvert/road may experience some overtopping during storms and some bank erosion at the culvert was noted, otherwise the culvert looks to be in good condition.

Tide Data

To determine the impact of the culvert on the tidal regime in the marsh, tide data was recorded for approximately a half day (low tide to low tide) on October 8, 2002. Tide conditions on this day were near monthly spring tide conditions. Tide data was measured on each side of the culvert using temporarily installed tide boards. Each board was marked in 0.10-foot increments. This allowed water surface elevation to be recorded to the nearest 0.05 foot. Key events such as tide direction (peak high or low) were noted. The plot showing the ocean side elevation, the marsh side elevation, and the elevation of the culvert inverts can be seen in the WPT17 tide data plot, Figure 3.

Observed Restriction at High Tide

Figure 3 shows that the maximum tide height on the marsh side is reduced by approximately 2.70 feet with a time lag of approximately two hours for this magnitude of tidal event. As the tidal plot shows, the high tide elevation is substantially reduced. This is true for the low tide elevations as well. It is evident that the culvert causes a significant reduction in tidal range.

Observed Restriction at Low Tide

Looking at the plot, the low tide elevation on the ocean side was about 6.60 feet lower than the marsh side. As mentioned the culvert is causing a significant reduction in tidal range in the marsh. The marsh side water surface elevation never makes it close to the culvert invert. The marsh seems to be healthy, but its vertical range has certainly been reduced due to the tide range reduction. Also, high velocities through the culvert were observed. If this culvert were replaced in the future hydraulic modeling could be used to properly size the culvert to increase tide range and reduce the current speeds.

Flooding Impacts

The area surrounding the marsh is primarily wooded. No low-lying structures were observed directly adjacent to the marsh during the field visit. However, before tidal flow is increased at the site, a careful review of the adjacent area and existing elevations is required to identify any potential flooding impacts.

Summary of Findings

1. The culvert is in good condition with some possible scour evident.

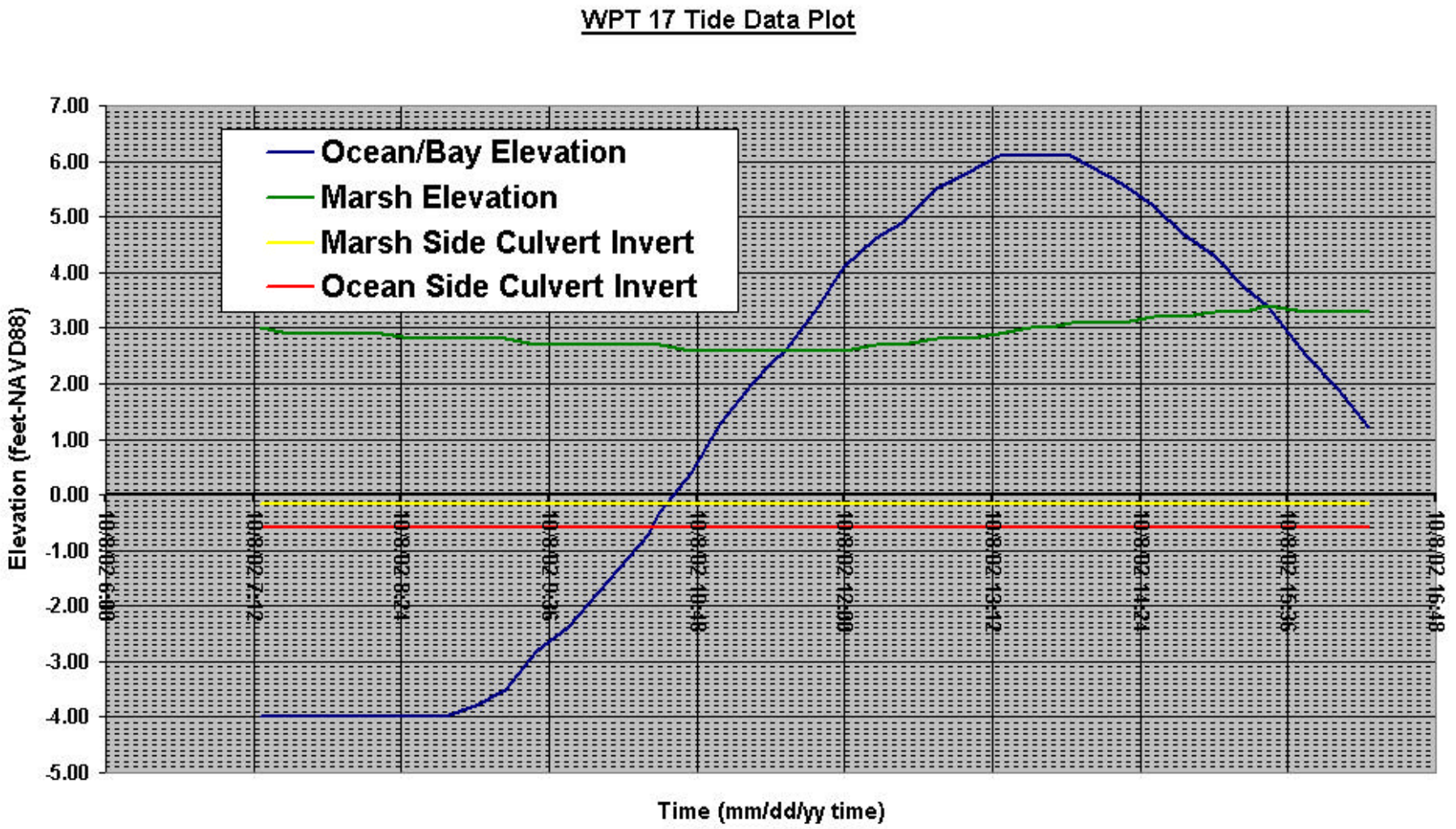
2. Providing a larger opening at the site with a lower culvert invert would increase the tidal inundation at high tide and provide improved drainage at low tide. Before this is considered, an ecological evaluation would be needed to compare the benefit of the existing pounded at low tide to an alternative inter-tidal area.

Site WPT17 – Marsh side of culvert.

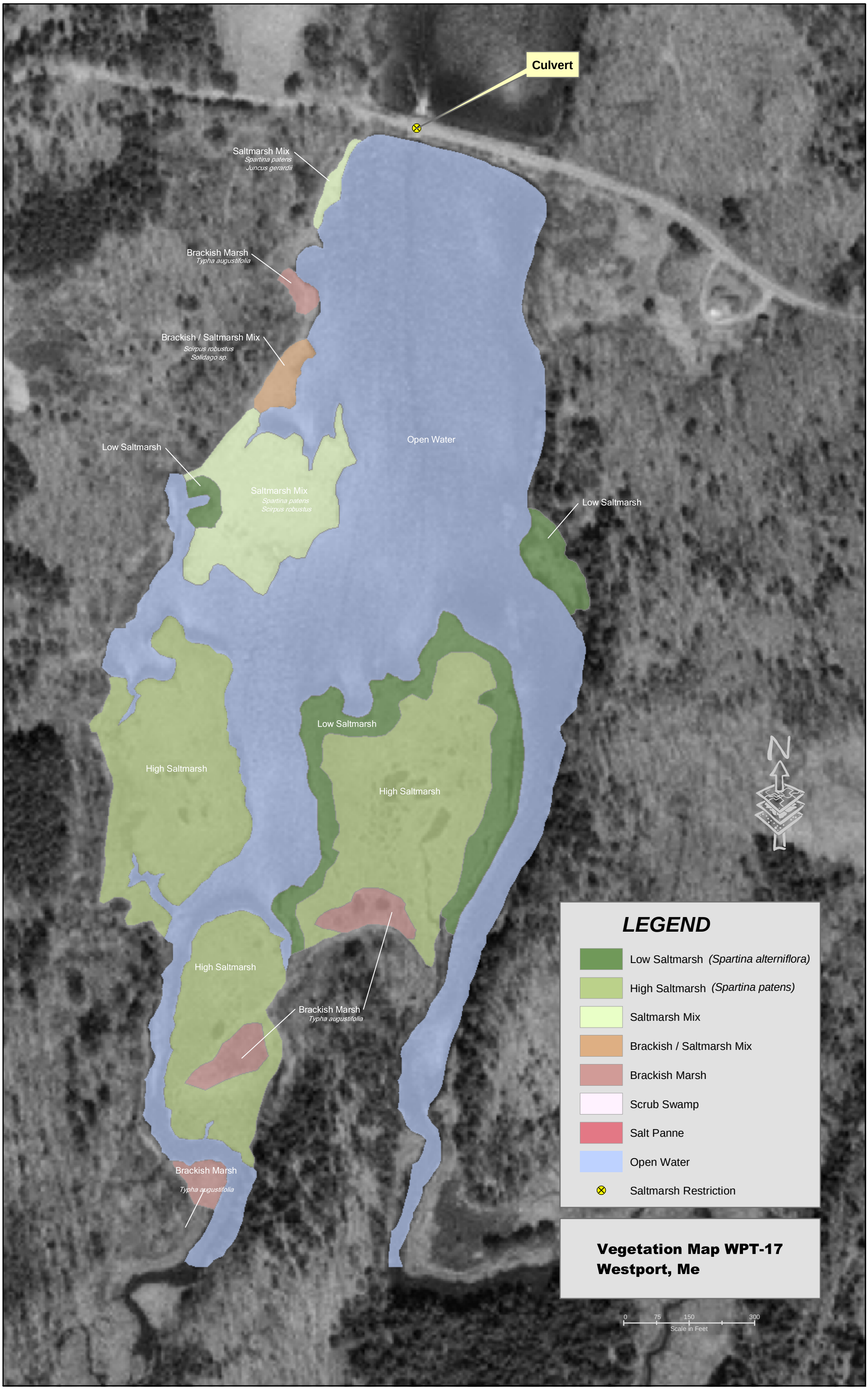
Site WPT17 – Ocean side of the culvert.

Site WPT17 – Typical view of open water on ocean side of culvert.

Site WPT17 – Typical view of marsh/open water on marsh side of culvert.



October 2002 WPT 17, Westport, Maine Figure 3


Culvert
Saltmarsh Mix
Spartina patens
Juncus gerardii
Brackish Marsh
Typha augustifolia
Brackish / Saltmarsh Mix
Scirpus robustus
Solidago sp.
Low Saltmarsh
Open Water
Saltmarsh Mix
Spartina patens
Scirpus robustus
Low Saltmarsh
Low Saltmarsh
High Saltmarsh
High Saltmarsh
High Saltmarsh
Brackish Marsh
Typha augustifolia
Brackish Marsh
Typha augustifolia
N
LEGEND
Low Saltmarsh (Spartina alterniflora)
High Saltmarsh (Spartina patens)
Saltmarsh Mix
Brackish / Saltmarsh Mix
Brackish Marsh
Scrub Swamp
Salt Panne
Open Water
Saltmarsh Restriction
Vegetation Map WPT-17
Westport, Me
0
75
150
300
Scale in Feet

APPENDIX 11

LIST OF ALL SITES FROM DATABASE

Appendix 11
ME DOT TIDAL RESTRICTION STUDY
272 sites sorted by Site ID

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
2	BAI 01	road		0	Harpswell	town	
3	BAT 01	bridge (#2959)	dam	291	Phippsburg	town	Existing fish and wildlife area do not desire to change conditio
4	BAT 02	RR		0	Bath	n/a	
5	BAT 03	road		0	Bath	state	
6	BAT 04	road	bridge (new)	16	Bath	state	new bridge
7	BAT 05	road		0	Bath	town	
8	BAT 06	road		0	Bath	state	
9	BAT 07	road		0	Bath	town	
10	BAT 08	road		0	Bath	town	
11	BAT 09	road		0	Woolwich	state	
12	BAT 10	road	culvert at Rte 1	3	Woolwich	state	Existing mitigation site at George Wright Road (B10 and B32)
13	BAT 11	road		0	Woolwich	town	
14	BAT 12	road		0	Woolwich	town	
15	BAT 13	road		9	ARRowsic	state	
16	BAT 14	road		34	ARRowsic	state	no restriction reported
17	BAT 15	road		52	ARRowsic	town	no restriction reported
18	BAT 16	road	dam	8	ARRowsic	private	no culvert - private road
19	BAT 17	road		11	ARRowsic	private	private road
20	BAT 18	bridge	dam Rte 1A	73	Brunswick	state	ME DEP study site; local opposition to change
21	BAT 19	RR		73	Brunswick	n/a	
22	BAT 20	road	Rte 1	73	Brunswick	state	no restriction reported
23	BAT 21	road	bridge	73	West Bath	state	no restriction reported
24	BAT 22	road		0	West Bath	town	
25	BAT 23	road		8	West Bath	town	
26	BAT 24	road		1	West Bath	town	
27	BAT 25	road	bridge	73	Brunswick	state	open to south
28	BAT 26	RR		73	Brunswick	n/a	
29	BAT 27	dam		0	Bath	town	
30	BAT 29	RR		5	West Bath	n/a	
31	BAT 30	road		0	Bath	?	
32	BAT 30 (LW)	road		5	Woolwich		
33	BAT 31	road		0	Bath	town	
34	BAT 32	road	culvert	1	Woolwich	town*	Existing mitigation site at George Wright Road (B10 and B32)
35	BAT 33	road		0	Woolwich	state	
36	BBH 01	road		0	Boothbay	state	
37	BBH 02	road	culvert	0	Boothbay	state	
38	BBH 03	road	dam	0	Boothbay Harbor	town	
39	BBH 04	road		3	Boothbay Harbor	state	
40	BBH 05	road	bridge	0	Boothbay Harbor	state	
41	BBH 06	road	bridge	0	Boothbay Harbor	state	

Appendix 11
ME DOT TIDAL RESTRICTION STUDY
272 sites sorted by Site ID

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
42	BBH 07	road	bridge	1	Southport	state	
43	BBH 08	road	bridge	0	Southport	state	
44	BBH 09	road	bridge	0	Southport	state	
45	BBH 10	road	culvert	0	Southport	state	
46	BBH 11	road	bridge	0	Georgetown	state	
47	BBH 12	road		0	Georgetown	town	
48	**BBH 13**	**road**	**culverts**	**24**	**Georgetown**	**state - DOC**	
49	BBH 14	road	bridge	72	Georgetown	state - DOC	
50	BBH 15	road	culvert	4	Boothbay Harbor	town	
51	BRK 01	road		2	Brunswick	town	
52	BRK 02	RR		0	Brunswick	n/a	
53	BRK 03	road		0	Brunswick	town	
54	BRK 04	road		12	Brunswick	town	Thomas Point Road, Bowdoin Study site
55	BRK 05	road		0	Brunswick	town	
56	BRK 06	RR		0	Brunswick	n/a	
57	BRK 07	dam	culvert	0	Brunswick	state	culvert at Old Bath Rd
58	BRK 101	road	dam	0	Topsham	town	
59	BRK 102	RR	culvert	0	Topsham	n/a	
60	BRK 103	RR	culvert	9	Topsham		
61	BRK 104	RR		2	Bowdoinham	n/a	
62	BRK 105	road	culvert	0	Bowdoinham	town	
63	**BRK 106**	**road**	**bridge**	**430**	**Topsham**	**state**	
64	BRK 107	road	culvert	215	Topsham	town	not scheduled for replacement
65	BRK 108	road	culvert	3	Topsham	town	
66	CEL 01	beach		0	Cape Elizabeth	town	
67	CEL 02	beach		0	Cape Elizabeth	town	
68	CEL 03	road		1	Cape Elizabeth	town	
69	CEL 04	road		3	Cape Elizabeth	town	
70	CEL 05	road		0	Cape Elizabeth	town	
71	CEL 06	road		0	Cape Elizabeth	town	
72	CEL 07	road		3	Cape Elizabeth	town	
73	CEL 08	road		3	Cape Elizabeth	town	
74	CEL 09	road		0	Cape Elizabeth	town	
75	CEL 10	road		0	Cape Elizabeth	town	
76	CEL 102	road	culvert	10	Cape Elizabeth	town	Spurwink Ave.
77	CEL 103	road		0	Cape Elizabeth	town	
78	CEL 104	road		0	Cape Elizabeth	town	
79	CEL 106	road		0	Cape Elizabeth	town	
80	CEL 107	dam		0	Cape Elizabeth	town	
81	CEL 11	road		0	Cape Elizabeth	town	

Appendix 11
ME DOT TIDAL RESTRICTION STUDY
272 sites sorted by Site ID

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
82	CEL 12	beach		1	Cape Elizabeth	town	
83	FPT 01	road		0	Freeport	town	
84	FPT 02	road		4	Freeport	town	
85	FPT 03	road	bridge I-95	0	Freeport	state	
86	FPT 04	road		6	Freeport	town	
87	FPT 05	road	bridge I-95	2	Freeport	state	
88	FPT 06	road	bridge	32	Freeport	state	no restriction reported
89	FPT 07	road		0	Brunswick	town	
90	FPT 08	dam	culvert	5	Freeport	town	
91	FPT 09	road		2	Freeport	town	
92	FPT 10	road		0	Harpswell	town	
93	ORI 01	road		0	Harpswell	state	
94	ORI 02	road		10	Harpswell	private	fire pond
95	**ORI 03**	**road**	**culvert**	**29**	**Harpswell**	**town**	**Long Reach Lane, Bowdoin study site**
96	ORI 04	road		0	Brunswick	state	
97	ORI 05	road		12	Harpswell	state	
98	ORI 06	road		16	Harpswell	town	
99	ORI 08	road		4	Harpswell	state	
100	ORI 09	dam		14	Harpswell	state	
101	ORI 10	road		0	Harpswell	town	
102	ORI 11	road		12	Harpswell	town	Private landowner issue
103	ORI 12	road		18	Harpswell	town	
104	ORI 13	road		0	Harpswell	town	
105	ORI 14	dam		3	Harpswell	town	
106	ORI 15	road		0	Harpswell	town	
107	ORI 16	road	culvert	11	Harpswell	town	High head road, upstream marsh appears to be in good cond
108	ORI 17	road		5	Harpswell	town	
109	ORI 18	road		0	Harpswell	town	
110	ORI 21	road		1	Harpswell	town	
111	ORI 22	road		1	Harpswell	town	
112	ORI 23	road		1	Harpswell	town	
113	ORI 24	road		22	Harpswell	town	
114	ORI 25	road		5	Brunswick	town	
115	ORI 26	road	culvert	11	Brunswick	town	Rossmore Road, marsh appears in good condition
116	ORI 27	road		6	Brunswick	town	
117	ORI 28	road		0	Brunswick	town	
118	ORI 29	road		0	Brunswick	state	
119	ORI 30	road		0	Brunswick	state	
120	ORI 31	road		9	Brunswick	town	
121	ORI 32	road		0	Brunswick	BNAS	

Appendix 11
ME DOT TIDAL RESTRICTION STUDY
272 sites sorted by Site ID

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
122	ORI 33	road		13	Brunswick	bridge	Bowdoin Study site
123	ORI 34	road		0	Brunswick	town	
124	ORI 35	road		12	Harpswell	?	
125	PHI	road		0	Georgetown	?	
126	PHI ?	road		60	Phippsburg	?	
127	**PHI 01**	**road**	**culvert**	**10**	**Phippsburg**	**state**	**Route 209**
128	PHI 03	road		0	Phippsburg	town	
129	PHI 07	road		8	Phippsburg	town	
130	**PHI 102**	**road**	**culvert**	**3**	**Phippsburg**	**town**	
131	PHI 103	road		1	Phippsburg	state	
132	PHI 13	road		0	Arrowsic	state	
133	**PHI 14**	**road**	**culvert**	**26**	**Arrowsic**	**state**	
134	PHI 16	road	bridge	0	Georgetown	state	
135	**PHI 17a**	**road**	**culvert**	**33**	**Arrowsic**	**state**	**Indian Rest Road**
136	PHI 17b	road	no culvert	39	ARRowsic	town	
137	PHI 19	road		16	Georgetown	town	private fish and wildlife AREA
138	PHI 20	road		0	Georgetown	town	
139	PHI 23	road	bridge	2	Georgetown	state	
140	PHI 24	path		0	ARRowsic	town	
141	PHI 25	road	culvert	0	ARRowsic	town	
142	PHI 26	road		0	Phippsburg	state	
143	PHI 27	road		15	Phippsburg	private	private Sebasco Estates
144	PHI 28	?		7	Phippsburg	town	
145	PHI 29	road		0	West Bath	town	
146	PHI 30	road		0	Phippsburg	town	
147	PHI/SMP 101	road	culvert	0	Phippsburg	state	
148	PHI-AVS	road		0	Georgetown	state	
149	PRT 101	RR		310	Scarborough	n/a	study by others
150	PRT 102	RR		310	Scarborough	n/a	study by others
151	PRT 103	road		1	Old Orchard Beac	town	
152	PRT 104	RR		370	Scarborough	n/a	
153	PRT 105	RR		17	Scarborough	n/a	
154	PRT 106	RR		17	Scarborough	n/a	
155	PRT 107	RR		0	Scarborough	town	
156	PRT 108	road		0	Scarborough	state	
157	PRT 109	road		0	Scarborough	state	Blk Pt.
158	PRT 110	road		0	Scarborough	town	
159	PRT 111	road		0	Scarborough	state	Rte 1
160	PRT 112	road		0	Scarborough	state	
161	PRT 113	road		0	Scarborough	state	

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272 sites sorted by Site ID

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1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
162	PRT 114	road		0	Scarborough	town	
163	PRT 115	road		0	Scarborough	MTA	
164	PRT 116	road		0	Scarborough	town	
165	PRT 117	road		0	Scarborough	town	
166	PRT 118	road		0	Scarborough	town	
167	PRT 119	road	bridge	202	Scarborough	state	
168	PRT 120	road		40	Scarborough	town	
169	PRT 121	road	culvert	0	Scarborough	state	
170	PRT 122	road		1	Scarborough	town	
171	PRT 123	road	culvert	0	Scarborough	state	
172	PRT 124	road	culvert	0	Scarborough	state	Route 77
173	PRT 125	RR		0	Scarborough	n/a	
174	PRT 126	road	culvert	0	Scarborough	state	
175	PRT 127	road		0	Old Orchard Beac	town	
176	PRT 128	road		0	Scarborough	town	
177	PRT 129	road		0	Cape Elizabeth	town	
178	PRT 130	road		5	Cape Elizabeth		
179	PRT 131	?		0	Scarborough	?	
180	PRT 133	RR		0	Scarborough	n/a	
181	PRT 134	RR		0	Scarborough	n/a	
182	PRT 135	RR		361	Scarborough	n/a	
183	PRT 136	road	embankment	0	Scarborough	town	
184	PRT 312a	road	bridge	90	Scarborough	state	
185	PRT 312b	road	culvert	49	Scarborough	town	Cascade Brook, USFWS study
186	PRT 315	RR		370	Scarborough	n/a	
187	PRT 316	road	tide gate	389	Scarborough	state	
188	PTE 01	road	culvert I-95	0	Falmouth	state	
189	PTE 02	road	culvert I-95	0	Falmouth	state	
190	PTE 03	dam	dam	0	Falmouth	state	
191	PTE 04	road	bridge	17	Falmouth	state	
192	PTE 05	road	bridge I-95	0	Falmouth	state	
193	PTE 06	road	culvert	4	Long Island	n/a	
194	PTE 07	beach?		0	Long Island	n/a	
195	PTE 08	?	culvert	0	Long Island	n/a	
196	PTE 09	road	culvert	0	Portland	n/a	
197	PTE 10	road	dam	0	Portland	n/a	
198	PTE 11	road		0	Portland	n/a	
199	PTE 12			0	Portland	n/a	
200	PTW 01	road		0	South Portland	town	
201	PTW 02	road		9	South Portland	town	

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
202	PTW 03	RR		0	South Portland	n/a	
203	PTW 04	road		0	South Portland	town	
204	PTW 05	road		0	South Portland	town	
205	PTW 06			0	South Portland	town	
206	PTW 07	road		2	South Portland	town	
207	PTW 08	?		0	South Portland	town	
208	PTW 09			0	South Portland	town	
209	PTW 10			0	South Portland	town	
210	PTW 11	road		1	South Portland	town	
211	PTW 12	road		0	South Portland	town	
212	PTW 13	RR		9	South Portland	n/a	
213	PTW 14	road		0	Portland	town	
214	PTW 15	RR	embankement	0	Portland	n/a	
215	PTW 16	RR		35	Portland	n/a	
216	PTW 17	RR	embankement	0	Portland	n/a	
217	PTW 19	road	bridge	0	Portland	state	
218	PTW 20	road		0	Portland	town	
219	PTW 21	road		0	Portland	town	
220	PTW 22	road	I-295	2	Portland	state	
221	PTW 23		I-95	0	Portland	state	
222	PTW 24	road	I-295	2	Portland	state	
223	PTW 26	road	I-95	0	Portland	state	
224	SMP 01	road		3	Phippsburg	town	
225	SMP 02a	road		1	Phippsburg	town	
226	SMP 02b	road		1	Phippsburg	town	
227	**SMP 03**	**road**	**culvert**	**12**	**Phippsburg**	**state**	**Route 216**
228	SMP 04	road		0	Phippsburg	town	
229	SMP 05	road		0	Phippsburg	town	
230	SMP 06	road		0	Phippsburg	town	
231	SMP 07	road		4	Phippsburg	state	
232	SMP 100	road		22	Phippsburg	state	
233	WPT 01	road	culvert	0	Edgecomb	town	
234	WPT 02	RR		3	Wiscasset	n/a	
235	WPT 03	?		5	Wiscasset	town	
236	WPT 04	road	culvert	0	Wiscasset	town	
237	WPT 05	RR		5	Wiscasset	town	
238	WPT 06	road	dam	3	Edgecomb	town	
239	WPT 07	road	bridge	0	Westport	state	
240	WPT 08	road	bridge	0	Wiscasset	state	
241	WPT 09	road	bridge	0	Wiscasset	town	

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ME DOT TIDAL RESTRICTION STUDY
272 sites sorted by Site ID

	A	B	C	D	E	F	G
1	**Site ID**	**Crossing_type**	**Restriction**	**Possible Wetland Area Impact (acres)**	**Town**	**State/Town Road**	**Comment**
242	WPT 10	road	bridge	3	Wiscasset	town	
243	WPT 11	road	culvert	0	Edgecomb	town	
244	WPT 12	road	bridge	1	Edgecomb	state	
245	WPT 13	road	culvert	0	Woolwich	town	
246	WPT 14	road	culvert	0	Westport	town	
247	WPT 15	road		0	Boothbay	town	
248	WPT 16	road		0	Boothbay	town	
249	**WPT 17**	**road**	**culvert**	**37**	**Westport**	**town**	
250	WPT 18	road	dam	9	Westport	town	
251	WPT 19	road	culvert	0	Westport	town	
252	WPT 20	road	culvert	0	Westport	town	
253	WPT 21	road	culvert	0	Boothbay	town	
254	WPT 22	road		0	Boothbay	town	
255	WPT 23	road		0	Boothbay	town	
256	WPT 24	road		0	Boothbay	town	
257	WPT 25	road	bridge	10	Westport	state	
258	WPT 26	road	bridge	0	Boothbay	state	
259	WPT 27	road	bridge	0	Boothbay	state	
260	WPT 28	RR		13	Woolwich	town	
261	WPT 29	RR		6	Wiscasset	town	
262	YAR 01	road		3	Yarmouth	town	
263	YAR 02	road		0	Yarmouth	town	
264	YAR 03	road	bridge I-95	0	Yarmouth	state	
265	YAR 04	road		10	Yarmouth	town	
266	YAR 05	road	I-95	132	Yarmouth	state	
267	YAR 06	road		2	Freeport	town	
268	YAR 07	road		0	Freeport	town	
269	YAR 08	road		0	Freeport	town	
270	YAR 09	road		0	Freeport	town	
271	YAR 10		dam	0	Yarmouth	town	
272	YAR 11		dam	0	Yarmouth	town	
273	YAR 12		dam	0	Yarmouth	town	

Maine DOT
Tidal Restriction Study Sites

Legend

- Site ID

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